BOSTON UNIVERSITY

SCHOOL OF EDUCATION

THESIS

CAUSES OF CHANGES IN GRIP STRENGTH IN COLLEGE MEN

Submitted by

Edward Atherton Coray
(A.B., Wheaton, 1923)

In partial fulfillment of requirements
for the degree of Master of Education.

1938

First Reader: Frederick R. Rogers, Professor of Education
Second Reader: Edgar W. Everts, Associate Professor of Physical Education
Third Reader: Roy O. Billett, Professor of Education

TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

INTRODUCTION

The Problem

The problem of this monograph is first, to determine the factors and conditions in college life which cause the grip strength of men to fluctuate. Secondly, an analysis will be made of the utility of the grip strength test as a simple and practical method of checking the daily physical condition of men on athletic squads. Thirdly, the further possibilities of forecasting physiological changes by means of grip strength tests will be considered.

While it is admitted from the start that a grip strength score alone is not sufficient to completely compare an individual with a group, recent studies have been made, and studies that are in progress, contribute much evidence to support a growing belief that changes in grip strength from an individual's own norm are very significant. From evidence at hand it seems highly probable that the grip strength test does possess greater utility for an athletic coach than any other known method of checking the daily physical condition of men.

Present Methods

The vast majority of coaches use one of two methods to check on the daily physical fitness of their men, observation or weight charts. E. J. Mather, formerly basketball coach at the University of Michigan, was an exception to the rule, as he used a heart test[1] as a means of detecting a condition athletic men term "staleness". However, many coaches would

[1] E. J. Mather and E. D. Mitchell, BASKETBALL, Ann Arbor, Michigan: C. W. Graham, 1922

INTRODUCTION

The Problem

The problem of this monograph is first, to determine the factors and conditions in college life which cause the grip strength of men to fluctuate. Secondly, an analysis will be made of the utility of the grip strength test as a simple and practical method of checking the daily physical condition of men on athletic squads. Thirdly, the further possibilities of forecasting physiological changes by means of grip strength tests will be considered.

While it is admitted from the start that a grip strength score alone is not sufficient to completely compare an individual with a group, recent studies have been made, and studies that are in progress, contribute much evidence to support a growing belief that changes in grip strength from an individual's own norm are very significant. From evidence at hand it seems highly probable that the grip strength test does possess greater utility for an athletic coach than any other known method of checking the daily physical condition of men.

Present Methods

The vast majority of coaches use one of two methods to check on the daily physical fitness of their men, observation or weight charts. E. J. Mather, formerly basketball coach at the University of Michigan, was an exception to the rule, as he used a hand test[1] as a means of detecting a condition athletic men term "staleness". However, many coaches scoff

[1] E. J. Mather and E. D. Mitchell, BASKETBALL. Ann Arbor, Michigan: C. E. Green, 1922

not to be qualified to administer such a test, and the majority would not take the time for it. Students are limited in the time they can devote to practices, and coaches will not use tests unless they can be administered quickly.

While general appearance does possess some validity as a measure of physical fitness[1], it is highly subjective. Coaches rarely, if ever, take the time to make a careful observation of each man on the squad. If they did, many college men and high school boys, zealous to participate and thoughtless of physical consequences would succeed in concealing from the coach their true condition. Coaches in the field, who have an intelligent understanding of their responsibility for the health of their players, realize how difficult it is to break down the traditional "I'd die for dear old Rutgers" attitude. Furthermore, if a man is out of condition because of breach of generally accepted training rules, he has another reason for attempting to appear in the best of physical shape.

Weighing men, and the keeping of daily weight charts has been long in use and is still the most frequently recommended method, though it is always understood that observation should supplement weight checking. H. O. Crisler and E. E. Wieman, now head football coaches at Michigan and Princeton Universities respectively, have written,

"After players attain proper physical condition, the coach must watch that they remain physically fit throughout the season. Staleness is not an infrequent condition. It is evidenced by loss of weight, inability to sleep, and general irritability. The common causes of staleness are overwork, monotony and indiscretions in diet, particularly poisoning the system by overloading it with proteins. The cure for staleness is rest or change of activity and a revision of the diet. But better than the cure is prevention....

[1]Frederick Rand Rogers, FUNDAMENTAL ADMINISTRATIVE MEASURES IN PHYSICAL EDUCATION, Newton, Mass.: The Pleiades Company, 1932, page 29.

"The coach should carefully watch the weight of each player, and if after good condition is obtained there is one who does not regain, between practices, the weight naturally lost during practice, a checkup is in order."[1]

J. Craig Ruby, for thirteen years basketball coach at the University of Illinois, wrote:

"Staleness is a loss of condition. It occurs with many men near the end of a long and hard playing season. The staleness indicates that excess fatigue poisons are being developed which the player cannot throw off due to lowered resistence. Examinations or worry about scholastic standing or the success of the team may cause 'mental staleness'. Lack of enough sleep to allow the powers of recuperation to function may be the cause, also a lowered reserve due to some ailment such as a severe cold, tonsilitus, bad teeth, or an infection may be the cause. These causes may be summed up: (a) overwork, (b) mental strain, (c) loss of sleep, (d) physical disorders.

"The most noticeable symptom is the loss of weight. The player does not regain, in a day or two, the weight lost in a practice session. Since this is true, a team weight chart should be kept throughout the season. The players should weigh before and after each practice and the weights tabulated under the date of each practice session. The coach should watch this chart carefully. The player should regain the weight lost during practice by the time of the next practice."[2]

G. E. Bilik, former athletic trainer at Illinois University and a recognized authority in this field, likewise recommends weight charts together with careful observation.[3] Ward Lambert, well known basketball coach of Purdue University, places greater emphasis upon observation, and suggests that a lack of condition will soon be reflected in lack of playing ability.[4] If this be true, how valuable it would be for coaches to detect lack of condition in its early stages before players lose their efficiency!

Evidence will be offered in this paper which supports a belief that physiological disturbances frequently take place which are not indicated by changes in weight; which would not be noticeable by casual, and in some cases not even by careful, observation; but which are very noticeably indicated by changes in grip strength.

[1] H. O. Crisler and E. E. Wieman, PRACTICAL FOOTBALL, New York and London; McGraw-Hill Book Co., Inc., 1934, pp. 226-227

[2] J. Craig Ruby, COACHING BASKETBALL, Champaign, Ill.: J. Craig Ruby, 1931, pp. 25.

[3] G. E. Bilik, THE TRAINER'S BIBLE, New York: The Athletic Trainer's Supply Co., 1928, pp. 207-208.

[4] Ward Lambert, PRACTICAL BASKETBALL, Chicago: Athletic Journal Publishing Co., 1932, pp. 226-227

Delimitation

This study does not make any attempt to correlate changes in grip strength with major physical breakdowns nor diseases. Nor is any attempt made to use the scientific methods of the medical profession to support the validity of grip strength testing as a daily measure of general fitness.

One of the chief problems of athletic coaches is to know when and how the effectiveness of their men is being lost. It is the purpose of this study to help solve this problem.

Importance of the Study

If a coach can determine quickly and easily just when an athlete is going stale the coach can take measures to prevent that condition from reaching the point where it not only seriously lessens the athlete's effectiveness but weakens his health. J. Craig Ruby writes,

> "The Coach must not minimize the importance of physical condition because many games are won or lost on condition alone. The coach, of necessity, must expend considerable thought and care on the training of his men. He is entrusted with the physical development of growing boys and young men. The health of these players must not be jeopardized."[1]

Coaches who carefully watch and analyze weight charts determine a loss of condition by noticing a steady loss of weight. However, by the time this condition of staleness is reached only a complete rest from participation will bring the athlete back to normal. By this time, too, the man has become so nervous and irritable that his effectiveness in study and other activity has been seriously affected. It becomes a vital problem to know what brings on increases and decreases in physical vigor, and when these changes occur. Certainly student years are not spent worthily if physical strength is dissipated rather than built up. What great values might come from being able to discover changes in physical condition before they become serious!

[1] Ibid., pp. 21

Though grip strength tests have been used by psychologists for over a hundred years, athletic men, who should be most interested, continue to use crude methods of measurement.

It is very common for coaches to tell their players that they cannot be in the best of shape for a game unless they keep up on their sleep, watch their diet, etc. However, many men in colleges and boys in secondary schools, while accepting the theory that training rules are valuable in general, get the perverted idea that they themselves are exceptions to the rule, and believe that they can violate accepted training rules and still produce maximum results. If coaches could show men objective evidence of their condition, they could expect better co-operation in training. Furthermore, the coach would have a better check on his men, and could bar men from competition who did not at least maintain a normal standard. A valid, objective test would help coaches uncover weaknesses of men who were not in shape, but were hiding their true condition because of their zeal to play.

Review of Previous Related Studies

Dr. Armand Gamboa, a practicing physician in the city of Boston, Massachusetts has been making a study since the winter of 1936-37 of the clinical evaluation of grip strength as applied to the general practice of medicine.

In one report Dr. Gamboa cited eleven cases. The most interesting and significant case was that labeled Case 2. The subject had a regular practice of going on drunken "sprees" lasting from two weeks to a month. With the consent of the man, Dr. Gamboa took advantage of this habit to make a study.

The physician checked his grip strength before drinking. After the subject became intoxicated, regular doses of whiskey were given in hopes of preventing delirium tremens or other complications. Grip strength was checked daily, and for a period of six days scores dropped steadily. Then apparently the man had established a tolerance for drinking, and his scores remained fairly steady for fourteen days. On the twenty-first day his grip strength dropped about forty pounds in each hand. Three consulting physicians were called in, but medical examinations revealed nothing. Forty-eight hours later lobar penumonia set in. Again the period of grip strength remained steady for a period, this time seven days. On the eighth day of the disease another marked drop was recorded. From this time on the drop was steady, and on the ninth day he died.

In this study, as well as in other ten cases cited by Dr. Gamboa in this article, a decline in grip strength preceded all other signs of a change in condition.

In a report of further studies Dr. Gamboa divided the cases into the various specialty groups: obstetrical, orthopedic, endocrine, venereal, skin, cardio pulmonary, and gynecological. The study was made from the viewpoint of a general practitioner. As a general conclusion from his three months of study Dr. Gamboa believes it is quite likely that a manuometer will soon be recognized as a most valuable part of the physician's diagnostic equipment. The most important of all findings in this study was that grip strength can discover altered physiology in the human body before any definite symptoms or clinical findings manifest themselves.

Mr. Raleigh Glynn, a student at Boston University, made an experiment to test the effects of smoking upon grip strength and its relation to the effects upon blood pressure. Using himself as the subject, he established normal curves for grip strength, sistolic blood pressure, and diastollic blood pressure by taking tests and noting scores every minute. Then, smoking cigarettes constantly, he repeated the tests over twenty minute periods and established curves for each of the three during the smoking periods. Sistollic blood pressure dropped slowly until after the seventeenth test, when it took a rapid drop. Diastollic varied until after the sixteenth test, when it took a sudden drop. Grip strength showed a marked drop after the second test.

Mr. W. M. Marling, track coach at Boston University, studied the effect on grip strength of drinking a highball. After drinking the liquor he tested himself every five minutes. During the first fifteen minutes his grip strength rose ten points, then from that high point dropped twenty-one points in the next fifteen minutes. The temporary stimulation of the muscles was evidently paid for dearly in the reaction.

Dr. Guy M. Whipple in his publication, MANUAL OF MENTAL AND PHYSICAL TESTS, recommends grip strength tests as an index of general bodily strength, as an index of right handedness, as an index of endurance or fatigue, as a test to be used in combination with other strength tests, or for other comparative purposes. Dr. Whipple, however, does not mention any definite uses for the test.[1]

[1]Guy M. Whipple, MANUAL OF MENTAL AND PHYSICAL TESTS, Baltimore: Warwick and York, Inc., 1924.

Ralph N. Blakeman, Perry S. Jackson, and Dr. Frederick Rand Rogers conducted some experiments in grip strength testing relating to diurnal changes and fatigue effects; and reported them in a pamphlet[1] entitled FURTHER ADVENTURES WITH GRIP STRENGTH TESTS. While the authors freely admit in the pamphlet that their experiments were not carried far enough to warrant their drawing definite conclusions, they do raise many very interesting questions to stimulate further research in these directions.

Method of Procedure and Sources of Data

For purposes of this study data was secured from nine different sources. A varsity football squad of twenty-two men was studied for a period of seven weeks; a varsity basketball squad of fourteen men, eight weeks; varsity wrestling squad of twenty-three men, ten weeks; a dormitory group of thirty-four students, ten weeks; a group of five students doing part time work in the college heating plant, four weeks; a group of eight students doing part time work in the college cafeteria, ten weeks; and a rooming house group of ten, twelve weeks. In addition three men, interested in the study, used themselves as subjects for varying periods to gather data as evidence of diurnal changes. The number of subjects totals one hundred forty. Of these groups the varsity wrestling squad, the rooming house group, janitors, and cafeteria workers were studied under the most closely controlled conditions, and furnish the most significant data for individual changes.

[1]Ralph N. Blakeman, Perry S. Jackson, and Frederick Rand Rogers, FURTHER ADVENTURES WITH GRIP STRENGTH TESTS; Newton, Mass.: The Pleiades Co., 1936

In the football and basketball squads, men were carefully weighed and tested for right and left grip strength before and after each practice. Individual graphs were kept and an attempt made to account for all noticeable deviations. However, with a large number of men reporting at the same time, in a hurry to get to practice and in a hurry to get to supper after practice, it became impossible to keep accurate health logs. Under these conditions the data secured from these sources are more valuable as a study of the general effects of exercise than as a study of causes of individual changes.

The wrestling squad was subject to very careful study from January 3 to March 12, 1938. The type of practice work for this sport did not necessitate the entire group practicing together, so that the men were coming and going over a period of two hours. This made possible unhurried testing, with an opportunity to talk to each subject. Weight and grip strength testing was carried on regularly before and after practices, at weighing in periods before matches, and before and after matches. Health logs were kept, and any factors which might affect physical fitness noted and dated.

With other student groups grip strength tests were recorded daily, and deviations from a normal average carefully probed for causes.

From questionaire and college records, a background of knowledge of the subjects was obtained. Weight, age, average amount of sleep, academic program, extra-curricular program, work schedule, and exercise program were included in the data kept for each subject. Since the college from which the data was obtained carries on a physical fitness measurement program, it was hoped also to compare changes in P.F.I. (Physical Fitness Index) and S.I. (Strength Index) scores with changes in grip strength and weight; but since

the regular testing periods for P.F.I. did not coincide with the testing period of this research, it proved very difficult to get the subjects at the proper times, so that such a comparative study was postponed for the present.

Manuometers, manufactured by the Narragansette Machine Company of Providence Rhode Island, were used in this research, and instruments were calibrated by the Research Department of the Armour Institute of Technology in Chicago, and necessary adjustments made by the manufacturers just before beginning the study. Each instrument was stamped with a number so that they could be distinguished, and the same instrument was used throughout the testing period of any particular group.

Testing was done by the writer, by assistants, and by students in physical education. Each tester was trained in the technique of administration recommended by Dr. Frederick Rand Rogers[1], and each stayed with the same group throughout a testing period, so there would be no deviations due to a possible slight difference in technique. Records were kept carefully and observed regularly to keep the danger of error to a minimum.

Statement of Organization into Chapters

Following the introduction two chapters will be devoted to a report of the findings in a study of the wrestling squad, the first dealing with the physical effects from participation in matches and in different types of practices, and the second dealing with the effects coming from factors associated with intercollegiate matches. Chapter IV presents a study of varsity football and basketball squads to show the general results of daily

[1]Frederick Rand Rogers, PHYSICAL CAPACITY TESTS, New York: A. S. Barnes and Co., 1931.

practice in sports. Then follows a chapter which contributes evidences of diurnal changes in grip strength, and suggests when they are most apt to occur. Chapter VI reports studies of four groups of college men in which causes of changes in grip strength were probed. A summary chapter integrates findings and suggests uses for the grip strength test by athletic coaches.

CHAPTER II

GENERAL EFFECTS OF MATCHES AND PRACTICES ON THE WEIGHT AND GRIP STRENGTH OF VARSITY WRESTLERS

Beginning the day after Christmas vacation, January 3, and lasting through to the end of the season, March 12, grip strength and weight scores were recorded before and after each practice and match. From information gained through careful observation and from conversation with the men, any changes in the daily routine or conditions which might affect them physically were noted and recorded.

The squad was interested in the study and co-operated very well in giving their best efforts while gripping the manuometer and in reporting activities and conditions which might be factors in the study. Curiosity and an instinctive desire of men to do well in a test, particularly involving strength, stimulated them in the early part of the testing period. As the season went along, through their own personal observation they gained confidence in the validity of grip strength as a measure of physical fitness, and they became eager to know their scores. In a questionnaire, given each subject at the close of the testing period, the final question asked was "What conclusions, if any, have you drawn in your own mine to explain increases or decreases in your normal (or average) grip strength scores?" The large majority answered that colds, amount of sleep, and amount of exercise were factors. Others mentioned diet and a general "run down" condition due to an extremely strenuous program.

The study of this group was made under carefully controlled conditions, and reveals how very sensitive grip strength is to changes in physical condition, especially if we compare it to weight as a measure of the same.

Of the twenty-three subjects included in this part of the study a division is made which classifies regular participants as those who were in over half of the forty-two practices and matches,and irregular participants as those who were in less than half of the practices and matches. The former group includes nine and the latter, fourteen. Reasons for lack of participation varied. Inability to win a place on the team, injury, sickness, or lack of time prevented participation in matches. Lack of time, lack of enthusiasm, injury, and sickness kept men from practices. For purposes of this study it seemed best to make this division since the men who participated regularly, because of the greater regularity of their exercise, were apparently in better physical condition and in every case showed different results from the group who participated irregularly. Several contrasts between the two groups are shown which add weight to the significance of the study.

For purposes of analysis, before participation each time, a man was rated as normal or below normal. Below normal means that the subject was apparently below his normal physical condition due to lack of sleep, a cold, or some minor illness; and yet not seriously enough below par to warrant barring him from practice. Participation was subdivided into four types: light practice, medium practice, hard practice, and intercollegiate matches. Light practice means running and the practice of holds without

any strenuous work. A medium workout would involve the usual "day's order" of running, practicing of holds, and wrestling a few minutes with another squad member. A hard practice means either a tryout match for a place on the team with another squad member in the same weight division, or a heavy program of wrestling in practice.

The Effects of Medium (Normal) Practices

Table I on pages fifteen and sixteen gives a summary of scores of the nine regular participants in normal condition before and after medium practices. As revealed by this table, five of the men showed a slight gain in right grip strength and four showed slight losses. Two of the same four who lost slightly in right grip strength also showed a slight loss in left grip. The other seven showed a slight gain. Each man showed a slight loss in weight. The average changes in the group as a whole show a loss of .21 pounds in right grip, a gain of .30 pounds in left grip and a loss of 1.82 pounds in body weight. This would indicate that despite the sweating off of nearly two pounds per man the physical condition of each man as measured by grip strength was approximately the same immediately after practice as it was just before.

As a contrast to this, Table II, on page seventeen and eighteen, gives a summary of scores of the fourteen irregular participants in normal condition before and after medium practices. As revealed by this table, three of the fourteen showed a slight gain, one remained the same, and ten showed losses in right grip. Eleven showed losses and three slight gains in left grip. All fourteen showed losses in body weight. This group has an average loss of 5.54 pounds in right grip, 2.96 in left grip, and 1.10 pounds in

TABLE I

A SUMMARY OF SCORES OF THE NINE REGULAR PARTICIPANTS, IN NORMAL CONDITION, BEFORE AND AFTER MEDIUM PRACTICES

BEFORE PRACTICE:

sub-jects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	total of scores	individual averages	No. of such cases	total of scores	individual averages	No. of such cases	total of scores	individual averages
Be	19	2924	153.89	19	3117	164.05	19	3211	169.00
Bu	18	2653	147.39	12	1754	159.45	18	3140	174.44
E	17	1943	114.29	17	1991	117.12	18	2185	121.39
F	12	1664	138.67	12	1477	123.08	12	1921	160.08
He	22	2439	110.86	22	2238	101.73	22	2844	129.27
Ha	15	2146	143.07	15	2146	143.07	15	2993	199.51
Sc	19	2724	143.37	19	2573	135.42	19	3480	183.16
Sh	12	1467	122.25	12	1395	116.25	12	1395	116.25
P	21	2336	111.24	20	2116	105.80	21	3149	149.95
Totals	155	20296		148	18807		156	24318	
Averages		130.94			127.07			155.88	

TABLE I (CONTINUED)

AFTER PRACTICE:

sub-jects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	total of scores	individual averages	No. of such cases	total of scores	individual averages	No. of such cases	total of scores	individual averages
Be	19	2889	152.05	19	3094	162.84	19	3185.5	167.67
Bu	18	2628	146.00	12	1781	161.91	18	3113.0	172.94
E	17	1964	115.53	17	2014	118.49	18	2165.5	120.31
F	11	1512	137.45	12	1422	118.50	12	1905	158.75
He	22	2450	111.36	22	2251	102.31	22	2818	128.09
Ha	15	2163	144.20	15	2166	144.40	15	2973	198.20
Sc	19	2677	140.89	19	2581	135.84	19	3452	181.68
Sh	12	1493	124.41	12	1394	116.17	12	1383.5	115.29
P	21	2356	112.19	20	2148	107.40	21	3078	146.57
Totals	154	20132		148	18851		156	24073.5	
Averages		130.73			127.37			154.06	
Average Change		.21 (loss)			.30 (gain)			1.82 (loss)	

TABLE II

A SUMMARY OF SCORES OF THE FOURTEEN IRREGULAR PARTICIPANTS*, IN NORMAL CONDITION, BEFORE AND AFTER MEDIUM PRACTICE

BEFORE PRACTICE:

Sub-jects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of scores	Individual averages
Ba	2	190	145	2	229	114.5	2	263	131.5
C	13	1775	136.53	13	1657	127	11	1749	159
D	12	1440	120	12	1275	106.25	12	1574	131.17
G	7	928	132.57	7	871	124.43	7	1016	145.14
HerH	8	1038	129.75	8	1094	136.75	8	1271	158.88
La	4	500	125	4	485	121.25	4	582	145.5
Ll	9	1222	135.78	9	1087	120.78	9	1349	149.89
Lo	5	593	118.6	5	544	108.8	5	707	141.4
M	8	851	106.38	7	910	130	8	1116	139.5
N	7	924	132	7	886	126.57	7	975	139.28
OP	10	1123	112.3	10	1047	104.7	10	1272	127.2
R	4	432	108	4	396	99	4	564	141
Schn	3	400	133.33	3	378	126	3	371	123.67
T	1	140	140	1	140	140	1	166	166
Totals	93	11556		92	10899		91	13075	
Averages		124.26			118.47			142.63	

TABLE II (CONTINUED)

AFTER PRACTICE:

Subject	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of score	Individual averages
Ba	2	160	80	2	230	115	2	262	131
C	13	1678	129.08	13	1600	123.07	11	1737	157.91
D	12	1304	108.67	12	1238	103.17	12	1560	130
G	7	915	130.71	7	796	113.71	7	1006	143.71
HerH	8	1038	129.75	8	1097	137.13	8	1268	158.5
La	4	505	126.25	4	486	121.5	4	579	144.75
Ll	9	1137	126.33	9	1033	114.78	9	1340	148.89
Lo	5	575	115	5	534	106.8	5	700	140
M	8	808	101	7	879	125.57	8	1108	138.5
N	7	892	127.43	7	857	122.43	7	960	138
OP	10	1055	105.5	10	1001	100.1	10	1266	126.6
R	4	422	105.5	4	394	98.5	4	562	140.5
Schn	3	402	134	3	362	120.67	3	367	122.33
T	1	150	150	1	120	120	1	158	158
Totals	93	11041		92	10627		91	12879	
Averages		118.72			115.51			141.53	
Average change		5.54 (loss)			2.96 (loss)			1.10 (loss)	

TABLE II (continued)

ATLAS BRICKWORKS

Brick-yard	Total No. of employees	Total No. of days worked	Total output	Individual average output per employee	Individual average output per day worked
Bob-cat	1	288	1,000,000	1,000,000	3,472
Bob-cat	2	576	1,000,000	500,000	1,736
Bob-cat	3	864	1,000,000	333,333	1,157
Bob-cat	4	1,152	1,000,000	250,000	868
Bob-cat	5	1,440	1,000,000	200,000	694
Bob-cat	6	1,728	1,000,000	166,666	578
Bob-cat	7	2,016	1,000,000	142,857	496
Bob-cat	8	2,304	1,000,000	125,000	434
Bob-cat	9	2,592	1,000,000	111,111	385
Bob-cat	10	2,880	1,000,000	100,000	347
Bob-cat	11	3,168	1,000,000	90,909	315
Bob-cat	12	3,456	1,000,000	83,333	289
Bob-cat	13	3,744	1,000,000	76,923	267
Bob-cat	14	4,032	1,000,000	71,428	248
Bob-cat	15	4,320	1,000,000	66,666	231
Bob-cat	16	4,608	1,000,000	62,500	217
Bob-cat	17	4,896	1,000,000	58,823	204
Bob-cat	18	5,184	1,000,000	55,555	193
Bob-cat	19	5,472	1,000,000	52,631	182
Bob-cat	20	5,760	1,000,000	50,000	173
Bob-cat	21	6,048	1,000,000	47,619	165
Bob-cat	22	6,336	1,000,000	45,454	157
Bob-cat	23	6,624	1,000,000	43,478	150
Bob-cat	24	6,912	1,000,000	41,666	144
Bob-cat	25	7,200	1,000,000	40,000	138
Bob-cat	26	7,488	1,000,000	38,461	133
Bob-cat	27	7,776	1,000,000	37,037	128
Bob-cat	28	8,064	1,000,000	35,714	123
Bob-cat	29	8,352	1,000,000	34,482	119
Bob-cat	30	8,640	1,000,000	33,333	115
Bob-cat	31	8,928	1,000,000	32,258	112
Bob-cat	32	9,216	1,000,000	31,250	108
Bob-cat	33	9,504	1,000,000	30,303	105
Bob-cat	34	9,792	1,000,000	29,411	102
Bob-cat	35	10,080	1,000,000	28,571	99
Bob-cat	36	10,368	1,000,000	27,777	96
Bob-cat	37	10,656	1,000,000	27,027	93
Bob-cat	38	10,944	1,000,000	26,315	91
Bob-cat	39	11,232	1,000,000	25,641	89
Bob-cat	40	11,520	1,000,000	25,000	86
Bob-cat	41	11,808	1,000,000	24,390	84
Bob-cat	42	12,096	1,000,000	23,809	82
Bob-cat	43	12,384	1,000,000	23,255	80
Bob-cat	44	12,672	1,000,000	22,727	78
Bob-cat	45	12,960	1,000,000	22,222	77
Bob-cat	46	13,248	1,000,000	21,739	75
Bob-cat	47	13,536	1,000,000	21,276	73
Bob-cat	48	13,824	1,000,000	20,833	72
Bob-cat	49	14,112	1,000,000	20,408	70
Bob-cat	50	14,400	1,000,000	20,000	69
Bob-cat	51	14,688	1,000,000	19,607	68
Bob-cat	52	14,976	1,000,000	19,230	66
Bob-cat	53	15,264	1,000,000	18,867	65
Bob-cat	54	15,552	1,000,000	18,518	64
Bob-cat	55	15,840	1,000,000	18,181	63
Bob-cat	56	16,128	1,000,000	17,857	62
Bob-cat	57	16,416	1,000,000	17,543	60
Bob-cat	58	16,704	1,000,000	17,241	59
Bob-cat	59	16,992	1,000,000	16,949	58
Bob-cat	60	17,280	1,000,000	16,666	57
Bob-cat	61	17,568	1,000,000	16,393	56
Bob-cat	62	17,856	1,000,000	16,129	55
Bob-cat	63	18,144	1,000,000	15,873	54
Bob-cat	64	18,432	1,000,000	15,625	53
Bob-cat	65	18,720	1,000,000	15,384	53
Bob-cat	66	19,008	1,000,000	15,151	52
Bob-cat	67	19,296	1,000,000	14,925	51
Bob-cat	68	19,584	1,000,000	14,705	50
Bob-cat	69	19,872	1,000,000	14,492	50
Bob-cat	70	20,160	1,000,000	14,285	49
Bob-cat	71	20,448	1,000,000	14,084	48
Bob-cat	72	20,736	1,000,000	13,888	48
Bob-cat	73	21,024	1,000,000	13,698	47
Bob-cat	74	21,312	1,000,000	13,513	46
Bob-cat	75	21,600	1,000,000	13,333	46
Bob-cat	76	21,888	1,000,000	13,157	45
Bob-cat	77	22,176	1,000,000	12,987	45
Bob-cat	78	22,464	1,000,000	12,820	44
Bob-cat	79	22,752	1,000,000	12,658	43
Bob-cat	80	23,040	1,000,000	12,500	43
Bob-cat	81	23,328	1,000,000	12,345	42
Bob-cat	82	23,616	1,000,000	12,195	42
Bob-cat	83	23,904	1,000,000	12,048	41
Bob-cat	84	24,192	1,000,000	11,904	41
Bob-cat	85	24,480	1,000,000	11,764	40
Bob-cat	86	24,768	1,000,000	11,627	40
Bob-cat	87	25,056	1,000,000	11,494	39
Bob-cat	88	25,344	1,000,000	11,363	39
Bob-cat	89	25,632	1,000,000	11,235	39
Bob-cat	90	25,920	1,000,000	11,111	38
Bob-cat	91	26,208	1,000,000	10,989	38
Bob-cat	92	26,496	1,000,000	10,869	37
Bob-cat	93	26,784	1,000,000	10,752	37
Bob-cat	94	27,072	1,000,000	10,638	36
Bob-cat	95	27,360	1,000,000	10,526	36
Bob-cat	96	27,648	1,000,000	10,416	36
Bob-cat	97	27,936	1,000,000	10,309	35
Bob-cat	98	28,224	1,000,000	10,204	35
Bob-cat	99	28,512	1,000,000	10,101	35
Bob-cat	100	28,800	1,000,000	10,000	34
Bob-cat	101	29,088	1,000,000	9,900	34
Bob-cat	102	29,376	1,000,000	9,803	34
Bob-cat	103	29,664	1,000,000	9,708	33
Bob-cat	104	29,952	1,000,000	9,615	33
Bob-cat	105	30,240	1,000,000	9,523	33
Bob-cat	106	30,528	1,000,000	9,433	32
Bob-cat	107	30,816	1,000,000	9,345	32
Bob-cat	108	31,104	1,000,000	9,259	32
Bob-cat	109	31,392	1,000,000	9,174	31
Bob-cat	110	31,680	1,000,000	9,090	31
Bob-cat	111	31,968	1,000,000	9,009	31
Bob-cat	112	32,256	1,000,000	8,928	31
Bob-cat	113	32,544	1,000,000	8,849	30
Bob-cat	114	32,832	1,000,000	8,771	30
Bob-cat	115	33,120	1,000,000	8,695	30
Bob-cat	116	33,408	1,000,000	8,620	29
Bob-cat	117	33,696	1,000,000	8,547	29
Bob-cat	118	33,984	1,000,000	8,474	29
Bob-cat	119	34,272	1,000,000	8,403	29
Bob-cat	120	34,560	1,000,000	8,333	28
Bob-cat	121	34,848	1,000,000	8,264	28
Bob-cat	122	35,136	1,000,000	8,196	28
Bob-cat	123	35,424	1,000,000	8,130	28
Bob-cat	124	35,712	1,000,000	8,064	27
Bob-cat	125	36,000	1,000,000	8,000	27
Bob-cat	126	36,288	1,000,000	7,936	27
Bob-cat	127	36,576	1,000,000	7,874	27
Bob-cat	128	36,864	1,000,000	7,812	27
Bob-cat	129	37,152	1,000,000	7,751	26
Bob-cat	130	37,440	1,000,000	7,692	26
Bob-cat	131	37,728	1,000,000	7,633	26
Bob-cat	132	38,016	1,000,000	7,575	26
Bob-cat	133	38,304	1,000,000	7,518	26
Bob-cat	134	38,592	1,000,000	7,462	25
Bob-cat	135	38,880	1,000,000	7,407	25
Bob-cat	136	39,168	1,000,000	7,352	25
Bob-cat	137	39,456	1,000,000	7,299	25
Bob-cat	138	39,744	1,000,000	7,246	25
Bob-cat	139	40,032	1,000,000	7,194	24
Bob-cat	140	40,320	1,000,000	7,142	24
Bob-cat	141	40,608	1,000,000	7,092	24
Bob-cat	142	40,896	1,000,000	7,042	24
Bob-cat	143	41,184	1,000,000	6,993	24
Bob-cat	144	41,472	1,000,000	6,944	24
Bob-cat	145	41,760	1,000,000	6,896	23
Bob-cat	146	42,048	1,000,000	6,849	23
Bob-cat	147	42,336	1,000,000	6,802	23
Bob-cat	148	42,624	1,000,000	6,756	23
Bob-cat	149	42,912	1,000,000	6,711	23
Bob-cat	150	43,200	1,000,000	6,666	23
Bob-cat	151	43,488	1,000,000	6,622	22
Bob-cat	152	43,776	1,000,000	6,578	22
Bob-cat	153	44,064	1,000,000	6,535	22
Bob-cat	154	44,352	1,000,000	6,493	22
Bob-cat	155	44,640	1,000,000	6,451	22
Bob-cat	156	44,928	1,000,000	6,410	22
Bob-cat	157	45,216	1,000,000	6,369	21
Bob-cat	158	45,504	1,000,000	6,329	21
Bob-cat	159	45,792	1,000,000	6,289	21
Bob-cat	160	46,080	1,000,000	6,250	21
Bob-cat	161	46,368	1,000,000	6,211	21
Bob-cat	162	46,656	1,000,000	6,172	21
Bob-cat	163	46,944	1,000,000	6,134	21
Bob-cat	164	47,232	1,000,000	6,097	20
Bob-cat	165	47,520	1,000,000	6,060	20
Bob-cat	166	47,808	1,000,000	6,024	20
Bob-cat	167	48,096	1,000,000	5,988	20
Bob-cat	168	48,384	1,000,000	5,952	20
Bob-cat	169	48,672	1,000,000	5,917	20
Bob-cat	170	48,960	1,000,000	5,882	20
Bob-cat	171	49,248	1,000,000	5,847	19
Bob-cat	172	49,536	1,000,000	5,813	19
Bob-cat	173	49,824	1,000,000	5,780	19
Bob-cat	174	50,112	1,000,000	5,747	19
Bob-cat	175	50,400	1,000,000	5,714	19
Bob-cat	176	50,688	1,000,000	5,681	19
Bob-cat	177	50,976	1,000,000	5,649	19
Bob-cat	178	51,264	1,000,000	5,617	18
Bob-cat	179	51,552	1,000,000	5,586	18
Bob-cat	180	51,840	1,000,000	5,555	18
Bob-cat	181	52,128	1,000,000	5,524	18
Bob-cat	182	52,416	1,000,000	5,494	18
Bob-cat	183	52,704	1,000,000	5,464	18
Bob-cat	184	52,992	1,000,000	5,434	18
Bob-cat	185	53,280	1,000,000	5,405	18
Bob-cat	186	53,568	1,000,000	5,376	18
Bob-cat	187	53,856	1,000,000	5,347	17
Bob-cat	188	54,144	1,000,000	5,319	17
Bob-cat	189	54,432	1,000,000	5,291	17
Bob-cat	190	54,720	1,000,000	5,263	17
Bob-cat	191	55,008	1,000,000	5,235	17
Bob-cat	192	55,296	1,000,000	5,208	17
Bob-cat	193	55,584	1,000,000	5,181	17
Bob-cat	194	55,872	1,000,000	5,154	17
Bob-cat	195	56,160	1,000,000	5,128	17
Bob-cat	196	56,448	1,000,000	5,102	17
Bob-cat	197	56,736	1,000,000	5,076	16
Bob-cat	198	57,024	1,000,000	5,050	16
Bob-cat	199	57,312	1,000,000	5,025	16
Bob-cat	200	57,600	1,000,000	5,000	16

body weight. It should be noted that exceptions to the general results for this group are all with men who participated in a very small number of practices. It is quite evident, however, that the general rule for this group, whose averages in grip strength were normally lower than the regular participants before practices, lost noticeably in grip strength, whereas the regular participants remained approximately the same.

Attention should be drawn to the changes in weight. In each of the twenty-three cases loss in weight was noticeable, averaging in most cases approximately two pounds. The average difference between the two groups is only .72 pounds, with the regular participants showing the larger loss.

The statistics included in Tables I and II were gathered when subjects were normally well as far as a subjective examination could reveal condition. Subjects, in their own opinions, were physically fit. Each then participated in a normal practice. Even yet, a subjective examination could not distinguish the more fit from the less fit. It would be logical to assume that the nine, who were regular in daily practice should be better conditioned to withstand the effects of fatigue, and yet weight changes showed that the regulars lost slightly more than the irregulars. One could hardly conclude that this greater weight loss was a sign of less physical fitness. A more reasonable conclusion would be that weight loss was due to perspiration, and that the more fit worked harder, and thus lost more water. However, changes in grip strength apparently tell the story. The regulars, in superior condition, withstand the effects of fatigue and retained approximately their normal grip strength during practice, while the irregulars, weakened by the effects of fatigue, lost noticeably in grip strength.

The Effects of Matches

Table III on pages 21 and 22 gives a summary of scores of the regular participants before and after intercollegiate matches. Normal condition before matches can be assumed, since no man was allowed to enter such a match unless he was in a normally healthful condition. In analyzing this table it is rather striking to note that the right grip average before matches is nearly four points higher than the right grip average of the same group when in normal condition before a normal practice. Likewise the left grip is over three and a half pounds above the average. The only way to account for this is that the "keying up" of the emotions, which precedes an intercollegiate contest, stimulates grip strength.

The weight before matches is .57 pounds below the normal average. This is accounted for by the fact that several of the men deliberately took off weight before each match in order to keep within the limits of their weight divisions. According to rule, the men were weighed in five hours before each match, which enabled them to regain some of the weight before match time; but there was still a squad average of slightly over one-half a pound per man below normal.

It is significant to note the effects upon grip strength of intercollegiate matches as compared with the effects of medium practices. In the latter we find a group average loss of .21 in right grip and a gain of .30 in left grip; whereas in the former we find a loss of 8.87 in right grip and a loss of 8.92 in left grip. Every one of the nine men lost both right and left grip strength in match competition. It is difficult to be

TABLE III

A SUMMARY OF SCORES OF THE REGULAR PARTICIPANTS BEFORE AND AFTER INTERCOLLEGIATE MATCHES

BEFORE MATCH:

Subject	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	11	1729	157.18	11	1838	167.09	11	1835.5	166.86
Bu	11	1662	151.09	6	905	150.83	11	1899	172.64
E	1	123	123	1	130	130	1	119	119
F	6	847	141.17	6	734	122.33	6	937	156.17
He	11	1238	112.55	11	1152	104.73	11	1402	127.45
Ha	7	990	141.43	7	1005	143.59	7	1389	198.43
Sc	3	439	146.33	3	419	139.67	3	547	182.33
Sh	7	893	127.57	7	869	124.14	7	803	114.71
P	11	1240	112.73	11	1170	106.36	11	1630	148.18
Totals	68	9161		63	8222		68	10561.5	
Averages		134.72			130.51			155.31	

TABLE III

SUMMARY OF SCORES OF THE REGULAR PARTICIPANTS BEFORE AND AFTER INTERCOLLEGIATE MATCHES

BEFORE MATCH:

Sub-jects	RIGHT GRIP: No. of boys	Total score	Individual average	LEFT GRIP: No. of boys	Total score	Individual average	BOTH: No. of boys	Total score	Individual average
Se	11	1729	157.18	11	1832	167.09	11	1895.5	176.86
Su	11	1662	151.09	6	905	150.83	11	1899	172.64
E	1	129	129	1	130	130	1	119	119
T	6	847	141.17	6	764	127.33	6	937	156.17
He	11	1238	112.55	11	1152	104.73	11	1402	127.45
Ha	7	990	141.43	7	1005	143.57	7	1289	169.43
So	3	439	146.33	3	419	139.67	3	547	182.33
Sh	7	893	127.57	7	869	124.14	7	809	114.71
P	11	1240	112.73	11	1170	106.36	11	1690	146.18
Totals	68	9161		68	8702		68	10561.5	
Averages		134.72			130.91			155.31	

TABLE III (CONTINUED)

AFTER MATCH:

Subjects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	11	1660	150.9	11	1722	156.55	11	1816	156.09
Bu	11	1497	136.09	6	796	132.66	11	1878	170.73
E	1	110	110	1	108	108	1	118	118
F	6	730	121.67	6	672	112	6	929	154.83
He	11	1165	105.91	11	1074	97.64	11	1391	126.45
Ha	7	968	138.29	7	949	135.57	7	1381	197.29
Sc	3	416	138.67	3	411	137	3	541	180.33
Sh	7	834	119.14	7	782	111.71	7	798.5	114.07
P	11	1178	107.09	11	1146	104.19	11	1614	146.73
Totals	68	8558		63	7660		68	10466	
Averages		125.85			121.59			153.92	
Average Change		8.77 (loss)			8.92 (loss)			1.39 (loss)	

sure just how much of this loss is due to fatigue and how much to an emotional "let down"; but since the scores after matches are 5.09 and 5.48 pounds below normal averages, and 4.88 and 5.78 pounds below after normal practice averages, it would seem certain that considerable of the loss was due to fatigue from the mental and physical strain of competitive matches.

It is again significant to notice weight changes. The average loss in weight during matches was 1.39 pounds as compared with 1.82 in normal practices. Again loss in weight seems to be indicative of nothing except loss of water. Even though match competition is more strenuous while it lasts, the loss in weight was less than during normal practices, probably because practices lasted longer and caused the men to sweat more. Furthermore, men were partially dried out by making weight before matches, and it is logical that they should lose less by sweating during the match.

Table IV on pages twenty-four and twenty-five is a summary of scores of irregular participants before and after intercollegiate matches. The results in this table are not as significant as those in Table III, since nine of the fourteen in this group participated in a total of only sixteen matches as compared with the total of sixty-eight matches of the regular group. Four in this group participated in only one match and four participated in only two matches. Average losses in grip strength during matches exceeded the losses during normal practices by 1.84 in right grip and 5.04 in left grip. One would expect this group to have greater losses during matches than the regular group, but such is not the case. The right grip loss of this group is 7.38 as compared with the average of 8.87 of the other group, and the left grip loss is 8.00 as compared with 8.92 of the group which we are assuming to be better conditioned. However, another factor must be considered.

TABLE IV

A SUMMARY OF SCORES OF THE IRREGULAR PARTICIPANTS BEFORE AND AFTER INTERCOLLEGIATE MATCHES

BEFORE MATCH:

	RIGHT GRIP			LEFT GRIP			WEIGHT		
Subjects	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of scores	Individual averages
Ba	2	219	109.5	2	218	109	2	262	131
C	1	130	130	1	119	119	1	152	152
D	2	250	125	2	236	118	2	254	127
G	–	—	—	–	—	—	–	—	—
HerH	–	—	—	–	—	—	–	—	—
La	2	262	131	2	268	134	2	281	140.5
Ll	1	122	122	1	120	120	1	148	148
Lo	–	—	—	–	—	—	–	—	—
M	4	424	106	4	508	127	4	552	138
N	–	—	—	–	—	—	–	—	—
OP	–	—	—	–	—	—	–	—	—
R	1	130	130	1	98	98	1	139	139
Schn	2	257	128.5	2	245	122.5	2	244	122
T	1	150	150	1	140	140	1	158	158
	–	—		–	—		–	—	
Totals	16	1944		16	1952		16	2190	
Averages		121.5			122.0			136.87	

TABLE IV

EIGHTH GRADE

Name	Age	No. of Absences	Total Score	Individual Average	Total Score	No. of Absences	Individual Average	Total Score	No. of Absences	Individual Average
Adams, Ben	13	1	457	91.4	457	1	91.4	457	1	91.4
Brown, Mary	13	1	465	93.0	465	1	93.0	465	1	93.0
Cole, Ruth	13	1	470	94.0	470	1	94.0	470	1	94.0
Dunn, Jane	13	1	475	95.0	475	1	95.0	475	1	95.0
Evans, Paul	13	1	480	96.0	480	1	96.0	480	1	96.0
Fox, Alice	13	1	485	97.0	485	1	97.0	485	1	97.0
Green, Tom	13	1	490	98.0	490	1	98.0	490	1	98.0
Hall, Sue	13	1	495	99.0	495	1	99.0	495	1	99.0
Irwin, Dick	13	1	500	100.0	500	1	100.0	500	1	100.0
Jones, Ann	13	1	505	101.0	505	1	101.0	505	1	101.0
Kent, Bob	13	1	510	102.0	510	1	102.0	510	1	102.0
Lane, Eva	13	1	515	103.0	515	1	103.0	515	1	103.0
Mann, Joe	13	1	520	104.0	520	1	104.0	520	1	104.0
Nash, Kate	13	1	525	105.0	525	1	105.0	525	1	105.0
Owen, Lee	13	1	530	106.0	530	1	106.0	530	1	106.0
Page, Ann	13	1	535	107.0	535	1	107.0	535	1	107.0
Quinn, Ed	13	1	540	108.0	540	1	108.0	540	1	108.0
Reed, Mae	13	1	545	109.0	545	1	109.0	545	1	109.0
Smith, Jack	13	1	550	110.0	550	1	110.0	550	1	110.0
Total			10,175		10,175			10,175		
Average	13	1		101.75			101.75			101.75

TABLE IV (CONTINUED)

AFTER MATCH:

Subjects	RIGHT GRIP: No. of such cases	RIGHT GRIP: Total of scores	RIGHT GRIP: Individual averages	LEFT GRIP: No. of such cases	LEFT GRIP: Total of scores	LEFT GRIP: Individual averages	WEIGHT: No. of such cases	WEIGHT: Total of scores	WEIGHT: Individual averages
Ba	2	192	96	2	215	107.5	2	261	130.5
Ca	1	119	119	1	116	116	1	149	149
D	2	207	103	2	196	98	2	252	126
G	—	—	—	—	—	—	—	—	—
HerH	—	—	—	—	—	—	—	—	—
La	2	258	129	2	253	126.5	2	278	139
Ll	1	128	128	1	116	116	1	147	147
Lo	—	—	—	—	—	—	—	—	—
M	4	412	103	4	473	118.25	4	549	137.25
N	—	—	—	—	—	—	—	—	—
OP	—	—	—	—	—	—	—	—	—
R	1	110	110	1	100	100	1	139	139
Schn	2	260	130	2	235	117.5	2	244	122
T	1	140	140	1	120	120	1	157	157
	—	—	—	—	—		—	—	
Totals	16	1826		16	1824		16	2167	
Averages		114.12			114.00			136.00	
Average change		7.38 (loss)			8.00 (loss)			.87 (loss)	

Eleven of these sixteen matches terminated on falls within the regulation time, and the average wrestling time per match of this group was 6.14 minutes as compared with the average wrestling time of 7.08 minutes of the regular group. It seems reasonable to conclude that if the average wrestling time of the irregular group had equaled the average wrestling time of the regular group the average loss in grip strength during matches would have been greater.

A comparison of changes in weight shows that the average loss in weight during matches (.87) is less than the average loss in weight during normal practices (1.10), probably due to the shorter wrestling time of matches as compared with practices. Note that though the loss in weight is less, the loss in grip strength is greater. The greater loss in grip strength is again due to loss in bodily vigor as a result of fatigue from the emotional, mental and physical strain of match competition even though it is brief in point of time.

Effects of Hard Practices

Table V on the following pages shows a summary of scores of the regular participants in normal condition after hard practices. Here the average losses in grip strength exceed the losses of this group in any other type of practice. It is quite significant that the loss in weight is less and the loss in grip strength is more in a hard workout than in a medium practice. It is important that the difference in classification between a hard and a medium practice is due more to intensity rather than to length of time. One might easily sweat off more weight in a longer and less strenuous exercise period, but fatigue would be greater in a shorter but more intense period of wrestling.

TABLE V

A SUMMARY OF SCORES OF THE REGULAR PARTICIPANTS, IN NORMAL CONDITION, BEFORE AND AFTER HARD PRACTICES

BEFORE PRACTICE:

Subject	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	–	—	—	–	—	—	–	—	—
Bu	2	295	147.5	2	300	150	2	348	174
E	1	119	119	1	126	126	1	119	119
F	2	294	147	1	138	138	2	318	159
He	1	100	100	1	102	102	1	129	129
Ha	1	146	146	1	138	138	1	201	201
Sc	–	—	—	–	—	—	–	—	—
Sh	2	257	128.5	2	252	126	2	233	116.5
P	1	112	112	1	109	109	1	148	148
	—	—		—	—		—	—	
Totals	10	1323		9	1165		10	1239	
Averages		132.3			129.44			149.6	

TABLE V (CONTINUED)

AFTER PRACTICE:

Subjects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	–	—	—	–	—	—	–	—	—
Bu	2	283	141.5	2	300	150	2	343	171.5
E	1	118	118	1	111	111	1	118	118
F	2	250	125	1	130	130	2	315	157.5
He	1	102	102	1	97	97	1	128	128
Ha	1	140	140	1	130	130	1	200.5	200.5
Sc	–	—	—	–	—	—	–	—	—
Sh	2	235	117.5	2	235	117.5	2	232	116
P	1	111	111	1	106	106	1	148	148
Totals	10	1239		9	1109		10	1484.5	
Averages		123.9			123.22			148.45	
Average Change		8.4 (loss)			6.22 (loss)			1.15 (loss)	

The loss in grip strength is not as great in hard practices as in intercollegiate matches. The before-practice level is lower, probably due to the lesser emotional factor, and consequently this would lessen the degree of change, even though the physical exercise might be as great or even greater.

The comparatively small number of cases in this class lessens the value of this particular table.

Table VI on pages 30 and 31 gives a summary of scores of the irregular participants in normal condition, before and after hard practices. Here we find a decided loss in right and left grip and a slightly higher loss in weight than in the other types of practice. Undoubtedly these men suffer decided fatigue effects from these strenuous practices, and grip strength tests are sensitive to these changes.

Effects of Medium Practices on Men Below Normal Condition

Tabel VII on pages 32 and 33 gives a summary of the scores of the regular participants, below normal in physical condition, before and after taking a normal workout. A most significant comparison is that the group in a below-normal condition lost 5.92 and 6.20 pounds in grip strength during a normal workout; while the same group in normal physical condition taking the same kind of a workout lost but .21 in right grip and gained .30 in left grip.

Again weight showed up as a negative factor in diagnosing changes in fitness of the men. Average weights of the men involved were practically the same both before and after these practices as they were before and after practices when the men reported themselves to be in normal physical condition.

TABLE VI

A SUMMARY OF SCORES OF THE IRREGULAR PARTICIPANTS, IN NORMAL CONDITION, BEFORE AND AFTER HARD PRACTICES

BEFORE PRACTICE:

Subject	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of score	Individual averages
Ba	—	—	—	—	—	—	—	—	—
C	5	658	131.6	5	647	109.4	5	777	155.4
D	—	—	—	—	—	—	—	—	—
G	—	—	—	—	—	—	—	—	—
HerH	2	250	125	2	278	139	2	321	160.5
La	2	269	134.5	2	252	126	2	285	142.5
Ll	—	—	—	—	—	—	—	—	—
Lo	1	126	126	1	100	100	1	142	142
M	2	202	101	2	266	133	2	280	140
N	—	—	—	—	—	—	—	—	—
OP	2	221	110.5	2	212	106	2	254	127
R	—	—	—	—	—	—	—	—	—
Schn	2	272	136	2	259	129.5	2	248	124
T	3	470	156.67	3	403	134.33	3	505	168.33
Totals	19	2468		19	2417		19	2812	
Averages		129.89			127.21			148.00	

TABLE VI (CONTINUED)

AFTER PRACTICE:

Subjects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Ba	—	—	—	—	—	—	—	—	—
C	5	597	119.4	5	573	114.6	5	771	154.2
D	—	—	—	—	—	—	—	—	—
G	—	—	—	—	—	—	—	—	—
HerH	2	245	122.5	2	243	121.5	2	320	160
La	2	230	115	2	234	117	2	283	141.5
Ll	—	—	—	—	—	—	—	—	—
Lo	1	100	100	1	100	100	1	141	141
M	2	192	96	2	225	112.5	2	278	139
N	—	—	—	—	—	—	—	—	—
OP	2	203	101.5	2	196	98	2	252	126
R	—	—	—	—	—	—	—	—	—
Schn	2	252	126	2	227	113.5	2	247	123.5
T	3	401	133.67	3	387	128.67	3	493	164.33
Totals	19	2220		19	2184		19	2785	
Averages		116.84			114.94			146.57	
Average Change		13.05 (loss)			12.27 (loss)			1.43 (loss)	

TABLE XXXVI (CONTINUED)

TABLE VII

SUMMARY OF TOTALS OF REGULAR PARTICIPANTS, BELOW NORMAL CONDITION*, BEFORE AND AFTER MEDIUM PRACTICE

BEFORE PRACTICE:

Sub-jects	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	1	150	150	1	162	126	1	167	167
Bu	6	885	147.5	6	889	148.17	6	1054	175.66
E	6	708	118	6	735	122.5	6	727	121.17
F	6	692	138.4	6	610	122	6	805	161
He	5	551	110.2	5	506	101.2	5	645	129
Ha	4	559	139.75	4	587	146.75	4	796	199
Sc	—	—	—	—	—	—	—	—	—
Sh	5	624	124.8	5	576	115.2	5	578	115.6
P	2	204	102	2	204	102	2	296	148
Totals	35	4373		35	4269		35	5068	
Averages		125.23			121.97			144.8	

*Lack of sleep, food, sickness, etc.

TABLE VII (CONTINUED)

AFTER PRACTICE:

Sub-jects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	1	140	140	1	154	154	1	166	166
Bu	6	825	137.5	6	815	135.83	6	1044	174
E	6	680	113.33	6	709	118.17	6	721	120.17
F	6	665	133	6	543	108.6	6	799	159.8
He	5	520	104	5	501	100.2	5	638	127.6
Ha	4	552	138	4	573	143.25	4	789	197.25
Sc	—	—	—	—	—	—	—	—	—
Sh	5	584	116.8	5	546	109.2	5	576	115.2
P	2	209	114.5	2	211	105.5	2	295	147.5
Totals	35	4175		35	4052		35	5028	
Averages		119.31			115.77			143.66	
Average change		5.92 (loss)			6.20 (loss)			1.14 (loss)	

Table VIII on pages 35 and 36 gives a summary of scores of the irregular participants, below normal in physical condition, before and after a normal practice. General grip strength loss is slightly greater with this group than with the regular group under the same conditions. General loss in grip strength is also greater with this group during a normal practice, while below normal in condition, than with the same group during the same type of practice while in normal physical condition. Weight loss with this group is slightly less than with the regular group under the same conditions. Weight loss is also slightly less with this group, while below normal in condition, than is their loss in the same type of practice while in normal condition.

Effects of Light Practices

Days before matches and days after matches regular team members would take what they termed light practices. However, as the season wore on, it became rather common to omit practice entirely the day before matches. Then, since many matches were held on Saturday evenings, the squad would not assemble again until Monday afternoon. This made it difficult to secure as many cases as desired to study the effects of light practices.

However, Table IX on pages 37 and 38 is a summary which gives the type of results we could reasonably expect. Small gains in grip strength were made, indicating that a man in normal condition, properly conditioned for athletic participation, is stimulated to greater bodily vigor by light practices.

TABLE VIII

A SUMMARY OF SCORES OF THE IRREGULAR PARTICIPANTS, BELOW NORMAL CONDITION, BEFORE AND AFTER MEDIUM PRACTICES

BEFORE PRACTICE:

Sub-jects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Ba	—	—	—	—	—	—	—	—	—
C	—	—	—	—	—	—	—	—	—
D	2	250	125	2	236	118	2	254	127
G	1	149	149	1	130	130	1	144	144
HerH	3	368	122.67	3	412	137.33	3	321	107
La	—	—	—	—	—	—	—	—	—
Ll	—	—	—	—	—	—	—	—	—
Lo	—	—	—	—	—	—	—	—	—
M	3	286	95.33	3	379	126.33	3	418	139.33
N	—	—	—	—	—	—	—	—	—
OP	—	—	—	—	—	—	—	—	—
R	1	104	104	1	100	100	1	141	141
Schn	—	—	—	—	—	—	—	—	—
T	3	348	142.67	3	428	142.67	3	509	169.67
Totals	13	1585		13	1685		13	1787	
Averages		121.92			129.61			137.46	

TABLE VIII (CONTINUED)

AFTER PRACTICE:

Subject	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of scores	Individual averages	No. of such cases	Total of score	Individual averages
Ba	–	—	—	–	—	—	–	—	—
C	–	—	—	–	—	—	–	—	—
D	2	207	103.5	2	196	98	2	252	126
G	1	129	129	1	110	110	1	143	143
HerH	3	358	119.3	3	393	131	3	319	106.33
La	–	—	—	–	—	—	–	—	—
Ll	–	—	—	–	—	—	–	—	—
Lo	–	—	—	–	—	—	–	—	—
M	3	301	100.33	3	355	118.33	3	415	138.33
OP	–	—	—	–	—	—	–	—	—
R	1	100	100	1	96	96	1	140	140
Schn	–	—	—	–	—	—	–	—	—
T	3	429	143	3	424	141.33	3	505	168.33
Totals	13	1524		13	1574		13	1774	
Average		117.23			121.07			136.46	
Average change		4.69 (loss)			8.54 (loss)			1.00 (loss)	

TABLE IX

SUMMARY OF THE TOTALS OF THE NINE REGULAR PARTICIPANTS, IN NORMAL CONDITION, BEFORE AND AFTER LIGHT PRACTICES

BEFORE PRACTICE:

Subjects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	1	162	162	1	168	168	1	170	170
Bu	4	612	153	4	303	151.5	4	697	169.25
E	—	—	—	—	—	—	—	—	—
F	3	425	141.67	3	365	121.67	3	473	157.67
He	3	332	110.67	3	312	104	3	386	128.67
Ha	2	290	145	2	280	140	2	401	200.5
Sc	—	—	—	—	—	—	—	—	—
Sh	3	388	129.33	3	387	129	3	349	116.33
P	2	219	109.5	2	210	105	2	298	149
Totals	18	2428		18	2025		18	2774	
Averages		134.88			112.5			154.11	

TABLE XX

EFFECT OF THE AMOUNT OF THE FIRST APPLICATION OF NITROGEN ON THE YIELD AND QUALITY OF FLUE-CURED TOBACCO

BELOW AVERAGE:

EXPLANATION

Location	Variety	Rate of application	Yield per acre	Grade index	Value per acre	Yield per acre	Grade index	Value per acre	Yield per acre	Grade index	Value per acre
			No. of lbs.			No. of lbs.			No. of lbs.		
Surry	Ky. 14	40	1,145	54	$ 618	1,145	54	$ 618	1,145	54	$ 618
		80	1,385	57	789	1,385	57	789	1,385	57	789
		120	1,520	58	882	1,520	58	882	1,520	58	882
		160	1,600	59	944	1,600	59	944	1,600	59	944
		200	1,650	59	974	1,650	59	974	1,650	59	974
		240	1,680	59	991	1,680	59	991	1,680	59	991
		280	1,700	59	1,003	1,700	59	1,003	1,700	59	1,003
		320	1,710	59	1,009	1,710	59	1,009	1,710	59	1,009
		360	1,715	59	1,012	1,715	59	1,012	1,715	59	1,012
		400	1,720	59	1,015	1,720	59	1,015	1,720	59	1,015
		440	1,725	59	1,018	1,725	59	1,018	1,725	59	1,018
		480	1,730	59	1,021	1,730	59	1,021	1,730	59	1,021
		520	1,735	59	1,024	1,735	59	1,024	1,735	59	1,024
		560	1,740	59	1,027	1,740	59	1,027	1,740	59	1,027
		600	1,745	59	1,030	1,745	59	1,030	1,745	59	1,030
		640	1,750	59	1,033	1,750	59	1,033	1,750	59	1,033
		680	1,755	59	1,036	1,755	59	1,036	1,755	59	1,036
		720	1,760	59	1,039	1,760	59	1,039	1,760	59	1,039
		760	1,765	59	1,042	1,765	59	1,042	1,765	59	1,042
		800	1,770	59	1,045	1,770	59	1,045	1,770	59	1,045
		840	1,775	59	1,048	1,775	59	1,048	1,775	59	1,048
		880	1,780	59	1,051	1,780	59	1,051	1,780	59	1,051
		920	1,785	59	1,054	1,785	59	1,054	1,785	59	1,054
		960	1,790	59	1,057	1,790	59	1,057	1,790	59	1,057
		1000	1,795	59	1,060	1,795	59	1,060	1,795	59	1,060
		1040	1,800	59	1,063	1,800	59	1,063	1,800	59	1,063
		1080	1,805	59	1,066	1,805	59	1,066	1,805	59	1,066
		1120	1,810	59	1,069	1,810	59	1,069	1,810	59	1,069
		1160	1,815	59	1,072	1,815	59	1,072	1,815	59	1,072
		1200	1,820	59	1,075	1,820	59	1,075	1,820	59	1,075
		1240	1,825	59	1,078	1,825	59	1,078	1,825	59	1,078
		1280	1,830	59	1,081	1,830	59	1,081	1,830	59	1,081
		1320	1,835	59	1,084	1,835	59	1,084	1,835	59	1,084
		1360	1,840	59	1,087	1,840	59	1,087	1,840	59	1,087
		1400	1,845	59	1,090	1,845	59	1,090	1,845	59	1,090
		1440	1,850	59	1,093	1,850	59	1,093	1,850	59	1,093
		1480	1,855	59	1,096	1,855	59	1,096	1,855	59	1,096
		1520	1,860	59	1,099	1,860	59	1,099	1,860	59	1,099
		1560	1,865	59	1,102	1,865	59	1,102	1,865	59	1,102
		1600	1,870	59	1,105	1,870	59	1,105	1,870	59	1,105
		1640	1,875	59	1,108	1,875	59	1,108	1,875	59	1,108
		1680	1,880	59	1,111	1,880	59	1,111	1,880	59	1,111
		1720	1,885	59	1,114	1,885	59	1,114	1,885	59	1,114
		1760	1,890	59	1,117	1,890	59	1,117	1,890	59	1,117
		1800	1,895	59	1,120	1,895	59	1,120	1,895	59	1,120
		1840	1,900	59	1,123	1,900	59	1,123	1,900	59	1,123
		1880	1,905	59	1,126	1,905	59	1,126	1,905	59	1,126
		1920	1,910	59	1,129	1,910	59	1,129	1,910	59	1,129
		1960	1,915	59	1,132	1,915	59	1,132	1,915	59	1,132
		2000	1,920	59	1,135	1,920	59	1,135	1,920	59	1,135
		2040	1,925	59	1,138	1,925	59	1,138	1,925	59	1,138
		2080	1,930	59	1,141	1,930	59	1,141	1,930	59	1,141
		2120	1,935	59	1,144	1,935	59	1,144	1,935	59	1,144
		2160	1,940	59	1,147	1,940	59	1,147	1,940	59	1,147
		2200	1,945	59	1,150	1,945	59	1,150	1,945	59	1,150
		2240	1,950	59	1,153	1,950	59	1,153	1,950	59	1,153
		2280	1,955	59	1,156	1,955	59	1,156	1,955	59	1,156
		2320	1,960	59	1,159	1,960	59	1,159	1,960	59	1,159
		2360	1,965	59	1,162	1,965	59	1,162	1,965	59	1,162
		2400	1,970	59	1,165	1,970	59	1,165	1,970	59	1,165
		2440	1,975	59	1,168	1,975	59	1,168	1,975	59	1,168
		2480	1,980	59	1,171	1,980	59	1,171	1,980	59	1,171
		2520	1,985	59	1,174	1,985	59	1,174	1,985	59	1,174
		2560	1,990	59	1,177	1,990	59	1,177	1,990	59	1,177
		2600	1,995	59	1,180	1,995	59	1,180	1,995	59	1,180
		2640	2,000	59	1,183	2,000	59	1,183	2,000	59	1,183
		2680	2,005	59	1,186	2,005	59	1,186	2,005	59	1,186
		2720	2,010	59	1,189	2,010	59	1,189	2,010	59	1,189
		2760	2,015	59	1,192	2,015	59	1,192	2,015	59	1,192
		2800	2,020	59	1,195	2,020	59	1,195	2,020	59	1,195
		2840	2,025	59	1,198	2,025	59	1,198	2,025	59	1,198
		2880	2,030	59	1,201	2,030	59	1,201	2,030	59	1,201
		2920	2,035	59	1,204	2,035	59	1,204	2,035	59	1,204
		2960	2,040	59	1,207	2,040	59	1,207	2,040	59	1,207
		3000	2,045	59	1,210	2,045	59	1,210	2,045	59	1,210
		3040	2,050	59	1,213	2,050	59	1,213	2,050	59	1,213
		3080	2,055	59	1,216	2,055	59	1,216	2,055	59	1,216
		3120	2,060	59	1,219	2,060	59	1,219	2,060	59	1,219
		3160	2,065	59	1,222	2,065	59	1,222	2,065	59	1,222
		3200	2,070	59	1,225	2,070	59	1,225	2,070	59	1,225
		3240	2,075	59	1,228	2,075	59	1,228	2,075	59	1,228
		3280	2,080	59	1,231	2,080	59	1,231	2,080	59	1,231
		3320	2,085	59	1,234	2,085	59	1,234	2,085	59	1,234
		3360	2,090	59	1,237	2,090	59	1,237	2,090	59	1,237
		3400	2,095	59	1,240	2,095	59	1,240	2,095	59	1,240
		3440	2,100	59	1,243	2,100	59	1,243	2,100	59	1,243
		3480	2,105	59	1,246	2,105	59	1,246	2,105	59	1,246
		3520	2,110	59	1,249	2,110	59	1,249	2,110	59	1,249
		3560	2,115	59	1,252	2,115	59	1,252	2,115	59	1,252
		3600	2,120	59	1,255	2,120	59	1,255	2,120	59	1,255
		3640	2,125	59	1,258	2,125	59	1,258	2,125	59	1,258
		3680	2,130	59	1,261	2,130	59	1,261	2,130	59	1,261
		3720	2,135	59	1,264	2,135	59	1,264	2,135	59	1,264
		3760	2,140	59	1,267	2,140	59	1,267	2,140	59	1,267
		3800	2,145	59	1,270	2,145	59	1,270	2,145	59	1,270
		3840	2,150	59	1,273	2,150	59	1,273	2,150	59	1,273
		3880	2,155	59	1,276	2,155	59	1,276	2,155	59	1,276
		3920	2,160	59	1,279	2,160	59	1,279	2,160	59	1,279
		3960	2,165	59	1,282	2,165	59	1,282	2,165	59	1,282
		4000	2,170	59	1,285	2,170	59	1,285	2,170	59	1,285
		4040	2,175	59	1,288	2,175	59	1,288	2,175	59	1,288
		4080	2,180	59	1,291	2,180	59	1,291	2,180	59	1,291
		4120	2,185	59	1,294	2,185	59	1,294	2,185	59	1,294
		4160	2,190	59	1,297	2,190	59	1,297	2,190	59	1,297
		4200	2,195	59	1,300	2,195	59	1,300	2,195	59	1,300
		4240	2,200	59	1,303	2,200	59	1,303	2,200	59	1,303
		4280	2,205	59	1,306	2,205	59	1,306	2,205	59	1,306
		4320	2,210	59	1,309	2,210	59	1,309	2,210	59	1,309
		4360	2,215	59	1,312	2,215	59	1,312	2,215	59	1,312
		4400	2,220	59	1,315	2,220	59	1,315	2,220	59	1,315
		4440	2,225	59	1,318	2,225	59	1,318	2,225	59	1,318
		4480	2,230	59	1,321	2,230	59	1,321	2,230	59	1,321
		4520	2,235	59	1,324	2,235	59	1,324	2,235	59	1,324
		4560	2,240	59	1,327	2,240	59	1,327	2,240	59	1,327
		4600	2,245	59	1,330	2,245	59	1,330	2,245	59	1,330
		4640	2,250	59	1,333	2,250	59	1,333	2,250	59	1,333
		4680	2,255	59	1,336	2,255	59	1,336	2,255	59	1,336
		4720	2,260	59	1,339	2,260	59	1,339	2,260	59	1,339
		4760	2,265	59	1,342	2,265	59	1,342	2,265	59	1,342
		4800	2,270	59	1,345	2,270	59	1,345	2,270	59	1,345
		4840	2,275	59	1,348	2,275	59	1,348	2,275	59	1,348
		4880	2,280	59	1,351	2,280	59	1,351	2,280	59	1,351
		4920	2,285	59	1,354	2,285	59	1,354	2,285	59	1,354
		4960	2,290	59	1,357	2,290	59	1,357	2,290	59	1,357
		5000	2,295	59	1,360	2,295	59	1,360	2,295	59	1,360
		5040	2,300	59	1,363	2,300	59	1,363	2,300	59	1,363
		5080	2,305	59	1,366	2,305	59	1,366	2,305	59	1,366
		5120	2,310	59	1,369	2,310	59	1,369	2,310	59	1,369
		5160	2,315	59	1,372	2,315	59	1,372	2,315	59	1,372
		5200	2,320	59	1,375	2,320	59	1,375	2,320	59	1,375
		5240	2,325	59	1,378	2,325	59	1,378	2,325	59	1,378
		5280	2,330	59	1,381	2,330	59	1,381	2,330	59	1,381
		5320	2,335	59	1,384	2,335	59	1,384	2,335	59	1,384
		5360	2,340	59	1,387	2,340	59	1,387	2,340	59	1,387
		5400	2,345	59	1,390	2,345	59	1,390	2,345	59	1,390
		5440	2,350	59	1,393	2,350	59	1,393	2,350	59	1,393
		5480	2,355	59	1,396	2,355	59	1,396	2,355	59	1,396
		5520	2,360	59	1,399	2,360	59	1,399	2,360	59	1,399
		5560	2,365	59	1,402	2,365	59	1,402	2,365	59	1,402
		5600	2,370	59	1,405	2,370	59	1,405	2,370	59	1,405
		5640	2,375	59	1,408	2,375	59	1,408	2,375	59	1,408
		5680	2,380	59	1,411	2,380	59	1,411	2,380	59	1,411
		5720	2,385	59	1,414	2,385	59	1,414	2,385	59	1,414
		5760	2,390	59	1,417	2,390	59	1,417	2,390	59	1,417
		5800	2,395	59	1,420	2,395	59	1,420	2,395	59	1,420
		5840	2,400	59	1,423	2,400	59	1,423	2,400	59	1,423
		5880	2,405	59	1,426	2,405	59	1,426	2,405	59	1,426
		5920	2,410	59	1,429	2,410	59	1,429	2,410	59	1,429
		5960	2,415	59	1,432	2,415	59	1,432	2,415	59	1,432
		6000	2,420	59	1,435	2,420	59	1,435	2,420	59	1,435
		6040	2,425	59	1,438	2,425	59	1,438	2,425	59	1,438
		6080	2,430	59	1,441	2,430	59	1,441	2,430	59	1,441
		6120	2,435	59	1,444	2,435	59	1,444	2,435	59	1,444
		6160	2,440	59	1,447	2,440	59	1,447	2,440	59	1,447
		6200	2,445	59	1,450	2,445	59	1,450	2,445	59	1,450
		6240	2,450	59	1,453	2,450	59	1,453	2,450	59	1,453
		6280	2,455	59	1,456	2,455	59	1,456	2,455	59	1,456
		6320	2,460	59	1,459	2,460	59	1,459	2,460	59	1,459
		6360	2,465	59	1,462	2,465	59	1,462	2,465	59	1,462
		6400	2,470	59	1,465	2,470	59	1,465	2,470	59	1,465
		6440	2,475	59	1,468	2,475	59	1,468	2,475	59	1,468
		6480	2,480	59	1,471	2,480	59	1,471	2,480	59	1,471
		6520	2,485	59	1,474	2,485	59	1,474	2,485	59	1,474
		6560	2,490	59	1,477	2,490	59	1,477	2,490	59	1,477
		6600	2,495	59	1,480	2,495	59	1,480	2,495	59	1,480
		6640	2,500	59	1,483	2,500	59	1,483	2,500	59	1,483
		6680	2,505	59	1,486	2,505	59	1,486	2,505	59	1,486
		6720	2,510	59	1,489	2,510	59	1,489	2,510	59	1,489
		6760	2,515	59	1,492	2,515	59	1,492	2,515	59	1,492
		6800	2,520	59	1,495	2,520	59	1,495	2,520	59	1,495
		6840	2,525	59	1,498	2,525	59	1,498	2,525	59	1,498
		6880	2,530	59	1,501	2,530	59	1,501	2,530	59	1,501
		6920	2,535	59	1,504	2,535	59	1,504	2,535	59	1,504
		6960	2,540	59	1,507	2,540	59	1,507	2,540	59	1,507
		7000	2,545	59	1,510	2,545	59	1,510	2,545	59	1,510
		7040	2,550	59	1,513	2,550	59	1,513	2,550	59	1,513
		7080	2,555	59	1,516	2,555	59	1,516	2,555	59	1,516
		7120	2,560	59	1,519	2,560	59	1,519	2,560	59	1,519
		7160	2,565	59	1,522	2,565	59	1,522	2,565	59	1,522
		7200	2,570	59	1,525	2,570	59	1,525	2,570	59	1,525
		7240	2,575	59	1,528	2,575	59	1,528	2,575	59	1,528
		7280	2,580	59	1,531	2,580	59	1,531	2,580	59	1,531
		7320	2,585	59	1,534	2,585	59	1,534	2,585	59	1,534
		7360	2,590	59	1,537	2,590	59	1,537	2,590	59	1,537
		7400	2,595	59	1,540	2,595	59	1,540	2,595	59	1,540
		7440	2,600	59	1,543	2,600	59	1,543	2,600	59	1,543
		7480	2,605	59	1,546	2,605	59	1,546	2,605	59	1,546
		7520	2,610	59	1,549	2,610	59	1,549	2,610	59	1,549
		7560	2,615	59	1,552	2,615	59	1,552	2,615	59	1,552
		7600	2,620	59	1,555	2,620	59	1,555	2,620	59	1,555
		7640	2,625	59	1,558	2,625	59	1,558	2,625	59	1,558
		7680	2,630	59	1,561	2,630	59	1,561	2,630	59	1,561
		7720	2,635	59	1,564	2,635	59	1,564	2,635	59	1,564
		7760	2,640	59	1,567	2,640	59	1,567	2,640	59	1,567
		7800	2,645	59	1,570	2,645	59	1,570	2,645	59	1,570
		7840	2,650	59	1,573	2,650	59	1,573	2,650	59	1,573
		7880	2,655	59	1,576	2,655	59	1,576	2,655	59	1,576
		7920	2,660	59	1,579	2,660	59	1,579	2,660	59	1,579
		7960	2,665	59	1,582	2,665	59	1,582	2,665	59	1,582
		8000	2,670	59	1,585	2,670	59	1,585	2,670	59	1,585
		8040	2,675	59	1,588	2,675	59	1,588	2,675	59	1,588
		8080	2,680	59	1,591	2,680	59	1,591	2,680	59	1,591
		8120	2,685	59	1,594	2,685	59	1,594	2,685	59	1,594
		8160	2,690	59	1,597	2,690	59	1,597	2,690	59	1,597
		8200	2,695	59	1,600	2,695	59	1,600	2,695	59	1,600
		8240	2,700	59	1,603	2,700	59	1,603	2,700	59	1,603
		8280	2,705	59	1,606	2,705	59	1,606	2,705	59	1,606
		8320	2,710	59	1,609	2,710	59	1,609	2,710	59	1,609
		8360	2,715	59	1,612	2,715	59	1,612	2,715	59	1,612
		8400	2,720	59	1,615	2,720	59	1,615	2,720	59	1,615
		8440	2,725	59	1,618	2,725	59	1,618	2,725	59	1,618
		8480	2,730	59	1,621	2,730	59	1,621	2,730	59	1,621
		8520	2,735	59	1,624	2,735	59	1,624	2,735	59	1,624
		8560	2,740	59	1,627	2,740	59	1,627	2,740	59	1,627
		8600	2,745	59	1,630	2,745	59	1,630	2,745	59	1,630
		8640	2,750	59	1,633	2,750	59	1,633	2,750	59	1,633
		8680	2,755	59	1,636	2,755	59	1,636	2,755	59	1,636
		8720	2,760	59	1,639	2,760	59	1,639	2,760	59	1,639
		8760	2,765	59	1,642	2,765	59	1,642	2,765	59	1,642
		8800	2,770	59	1,645	2,770	59	1,645	2,770	59	1,645
		8840	2,775	59	1,648	2,775	59	1,648	2,775	59	1,648
		8880	2,780	59	1,651	2,780	59	1,651	2,780	59	1,651
		8920	2,785	59	1,654	2,785	59	1,654	2,785	59	1,654
		8960	2,790	59	1,657	2,790	59	1,657	2,790	59	1,657
		9000	2,795	59	1,660	2,795	59	1,660	2,795	59	1,660
		9040	2,800	59	1,663	2,800	59	1,663	2,800	59	1,663
		9080	2,805	59	1,666	2,805	59	1,666	2,805	59	1,666
		9120	2,810	59	1,669	2,810	59	1,669	2,810	59	1,669
		9160	2,815	59	1,672	2,815	59	1,672	2,815	59	1,672
		9200	2,820	59	1,675	2,820	59	1,675	2,820	59	1,675
		9240	2,825	59	1,678	2,825	59	1,678	2,825	59	1,678
		9280	2,830	59	1,681	2,830	59	1,681	2,830	59	1,681
		9320	2,835	59	1,684	2,835	59	1,684	2,835	59	1,684
		9360	2,840	59	1,687	2,840	59	1,687	2,840	59	1,687
		9400	2,845	59	1,690	2,845	59	1,690	2,845	59	1,690
		9440	2,850	59	1,693	2,850	59	1,693	2,850	59	1,693
		9480	2,855	59	1,696	2,855	59	1,696	2,855	59	1,696
		9520	2,860	59	1,699	2,860	59	1,699	2,860	59	1,699
		9560	2,865	59	1,702	2,865	59	1,702	2,865	59	1,702
		9600	2,870	59	1,705	2,870	59	1,705	2,870	59	1,705
		9640	2,875	59	1,708	2,875	59	1,708	2,875	59	1,708
		9680	2,880	59	1,711	2,880	59	1,711	2,880	59	1,711
		9720	2,885	59	1,714	2,885	59	1,714	2,885	59	1,714
		9760	2,890	59	1,717	2,890	59	1,717	2,890	59	1,717
		9800	2,895	59	1,720	2,895	59	1,720	2,895	59	1,720
		9840	2,900	59	1,723	2,900	59	1,723	2,900	59	1,723
		9880	2,905	59	1,726	2,905	59	1,726	2,905	59	1,726
		9920	2,910	59	1,729	2,910	59	1,729	2,910	59	1,729
		9960	2,915	59	1,732	2,915	59	1,732	2,915	59	1,732
		10000	2,920	59	1,735	2,920	59	1,735	2,920	59	1,735
		10040	2,925	59	1,738	2,925	59	1,738	2,925	59	1,738
		10080	2,930	59	1,741	2,930	59	1,741	2,930	59	1,741
		10120	2,935	59	1,744	2,935	59	1,744	2,935	59	1,744
		10160	2,940	59	1,747	2,940	59	1,747	2,940	59	1,747
		10200	2,945	59	1,750	2,945	59	1,750	2,945	59	1,750
		10240	2,950	59	1,753	2,950	59	1,753	2,950	59	1,753
		10280	2,955	59	1,756	2,955	59	1,756	2,955	59	1,756
		10320	2,960	59	1,759	2,960	59	1,759	2,960	59	1,759
		10360	2,965	59	1,762	2,965	59	1,762	2,965	59	1,762
		10400	2,970	59	1,765	2,970	59	1,765	2,970	59	1,765
		10440	2,975	59	1,768	2,975	59	1,768	2,975	59	1,768
		10480	2,980	59	1,771	2,980	59	1,771	2,980	59	1,771
		10520	2,985	59	1,774	2,985	59	1,774	2,985	59	1,774
		10560	2,990	59	1,777	2,990	59	1,777	2,990	59	1,777
		10600	2,995	59	1,780	2,995	59	1,780	2,995	59	1,780
		10640	3,000	59	1,783	3,000	59	1,783	3,000	59	1,783
		10680	3,005	59	1,786	3,005	59	1,786	3,005	59	1,786
		10720	3,010	59	1,789	3,010	59	1,789	3,010	59	1,789
		10760	3,015	59	1,792	3,015	59	1,792	3,015	59	1,792
		10800	3,020	59	1,795	3,020	59	1,795	3,020	59	1,795
		10840	3,025	59	1,798	3,025	59	1,798	3,025	59	1,798
		10880	3,030	59	1,801	3,030	59	1,801	3,030	59	1,801
		10920	3,035	59	1,804	3,035	59	1,804	3,035	59	1,804
		10960	3,040	59	1,807	3,040	59	1,807	3,040	59	1,807
		11000	3,045	59	1,810	3,045	59	1,810	3,045	59	1,810
		11040	3,050	59	1,813	3,050	59	1,813	3,050	59	1,813
		11080	3,055	59	1,816	3,055	59	1,816	3,055	59	1,816
		11120	3,060	59	1,819	3,060

TABLE IX (CONTINUED)

AFTER PRACTICE:

Subjects	RIGHT GRIP			LEFT GRIP			WEIGHT		
	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages	No. of such cases	Total of score	Individual averages
Be	1	161	161	1	172	172	1	169	169
Bu	4	618	154.5	4	322	161	4	693	173.25
E	—	—	—	—	—	—	—	—	—
F	3	429	143	3	364	121.33	3	472	157.33
He	3	337	112.33	3	332	110.67	3	383.5	127.83
Ha	2	289	144.5	2	274	137	2	400	200
Sc	—	—	—	—	—	—	—	—	—
Sh	3	390	130	3	381	127	3	348	116
P	2	232	116	2	222	111	2	296	148
Totals	18	2456		18	2067		18	2761.5	
Averages		136.43			114.83			153.42	
Average change		1.55 (gain)			2.33 (gain)			.69 (loss)	

The weight loss was less than the loss during a normal practice, and we would expect this, too, since without actual wrestling there would in all probability be less sweating.

It did not seem possible to gather data on the irregular participants for light practices. This was largely due to their small degree of participation in matches, which obviated the necessity of conserving energies in practice sessions.

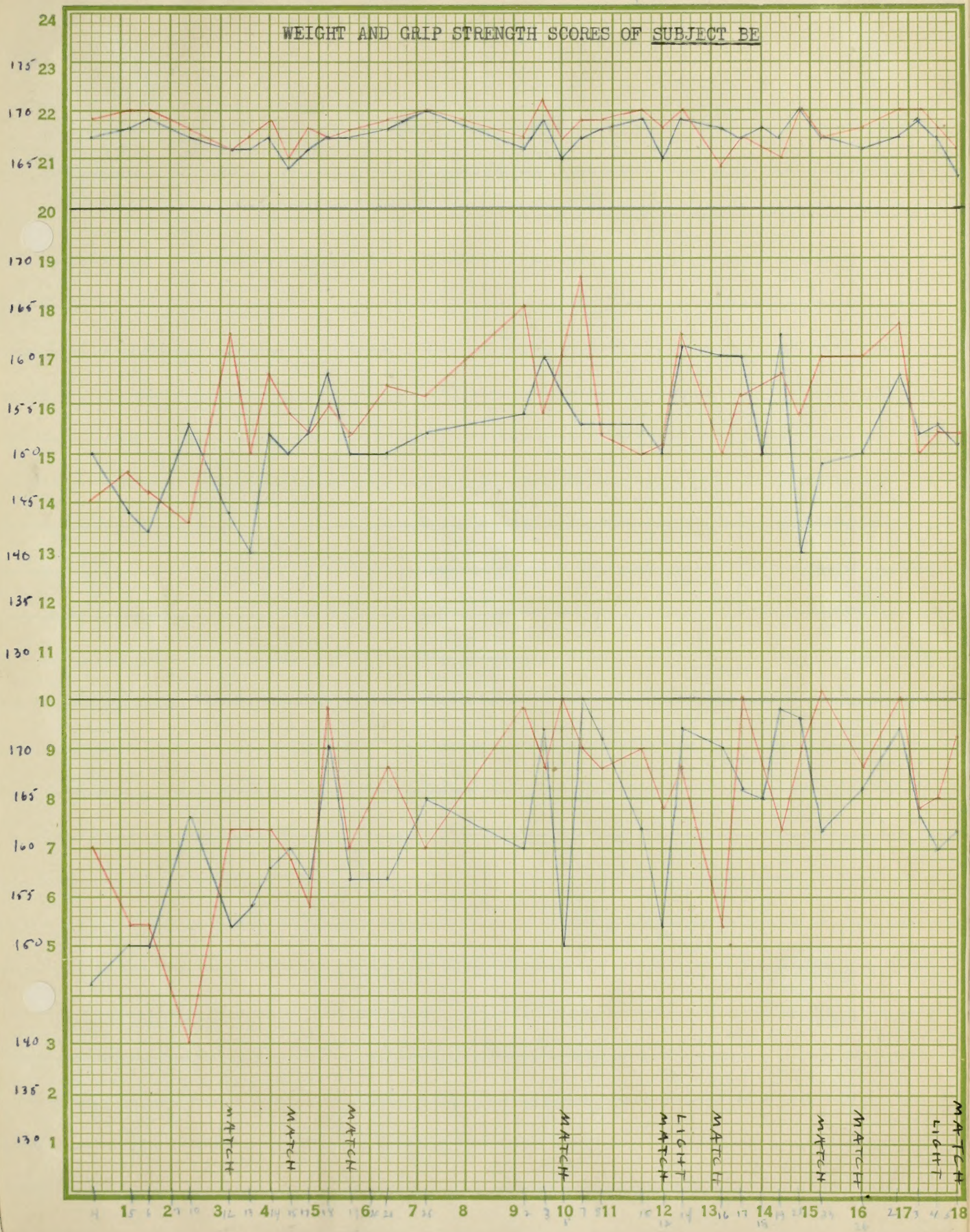
An attempt was made to gather data on the effects of hard practices on men below normal in condition. However, since men in this condition did not feel like taking a hard workout, and since they were not encouraged to do so, only two such cases were recorded: One man while feeling below par due to lack of sleep, and who on two different occasions participated in hard workouts. The average loss in his case in right grip was 18 pounds, and in left grip 15.5 pounds and in weight one pound. Considering the general trend of results as indicated in tables I - IX it is quite likely that further studies in this type of case will yield results comparable to the ones found in these two cases.

Case Studies of Wrestlers

Subject Be (Chart I on pages 40 and 41). This subject was twenty years of age, a natural left hander and was in his third year on the squad. He was the most successful wrestler on the team, finishing the season without the loss of a match. He is a natural athlete, with a strong body, good co-ordination, and even temperament. He carried a noraml academic load and averaged seven and one half to eight hours sleep a night.

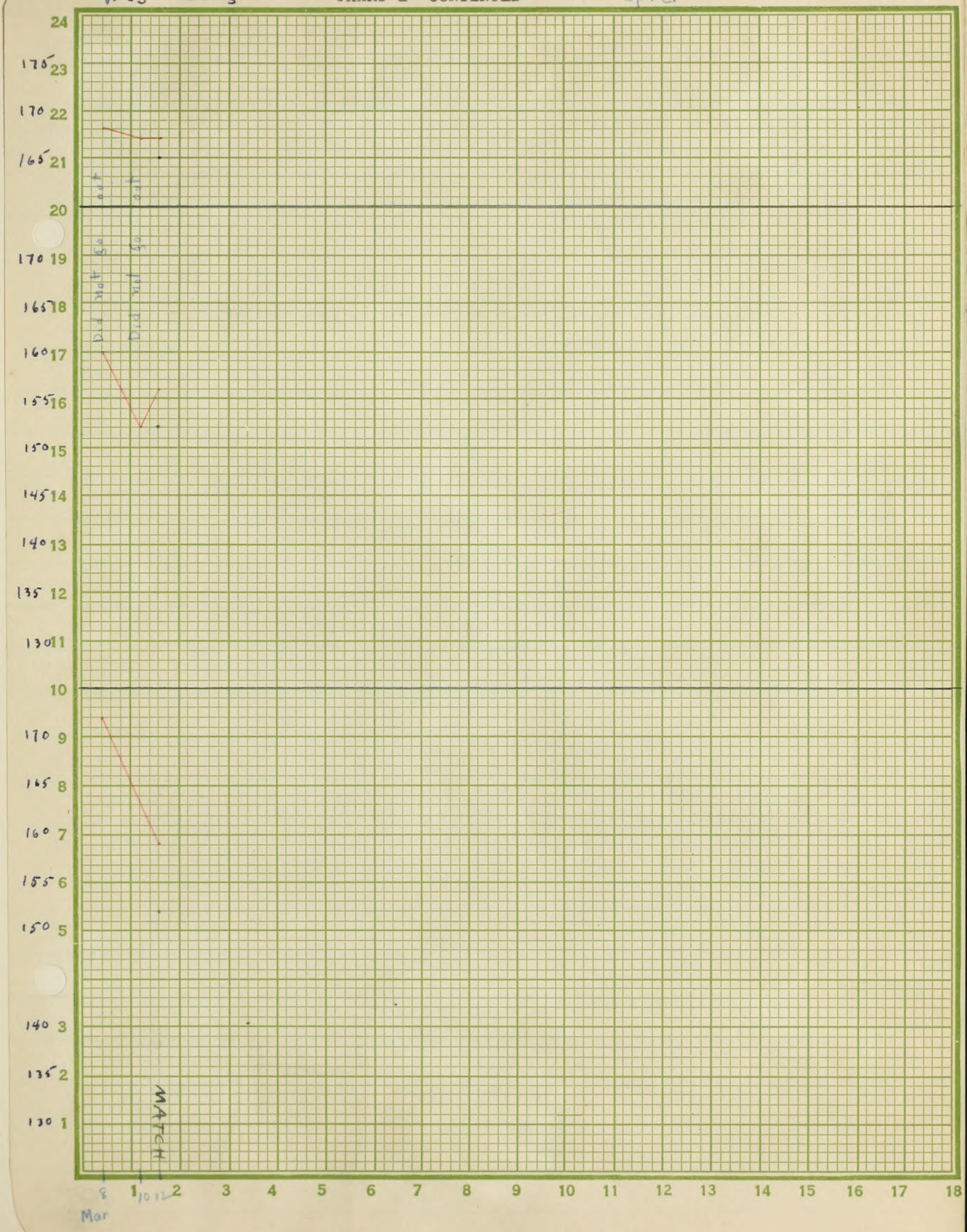
Wes Berghouse CHART I

– before
– after



Wes Berghouse CHART I--CONTINUED

– before
– after



His weight at the beginning of the testing period was 169 and his average for the entire season was 168.23. For matches he trained down in weight to wrestle in the 165 pound division, but at no time did he go below 163 and at no time higher than 171. Only once during the course of the season did he report himself to be below normal condition prior to practice and that was merely a tired feeling the day following a match. About the last three weeks of the season he complained of being unable to sleep well. This was probably due to nervousness because of his unbeaten record and an intense desire to finish with a "clean slate". The coach at least partially compensated for this nervousness by lightening up on his training program, which doubtless prevented a pronounced decline in physical powers. However, his grip strength scores, which had started at one forty-five right and one sixty left and risen steadily to midseason peaks of one sixty-eight right and one seventy-five left, tended to decline the latter part of the season until before the final matches he averaged one fifty-six right and one fifty-nine left. His averages for the entire year were 155.16 right and 165.16 left.

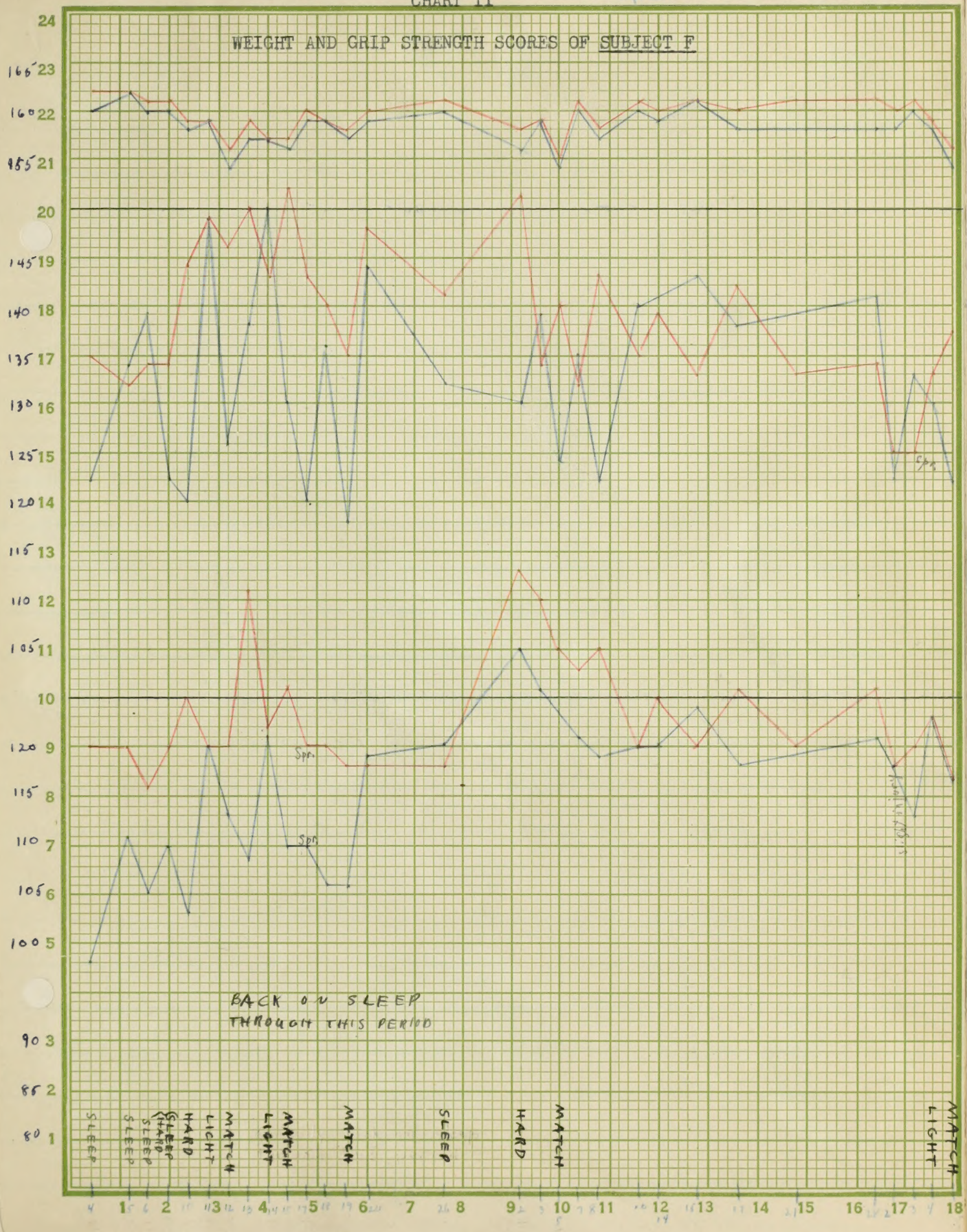
Subject F (Chart II on pages 43 and 44) This subject was 22 years of age, a right hander, fourth year on the squad. He is not a natural athlete, but achieves considerable success through sheer will power and a dogged determination to succeed. He is very active in extra-curricular activities, and is an honor student as well. He does not get too much sleep, averaging about six hours per night. The first three weeks of the season he was especially back on sleep and his very high losses in grip strength give a very clear picture of his lack of power to resist fatigue.

John Frame

43

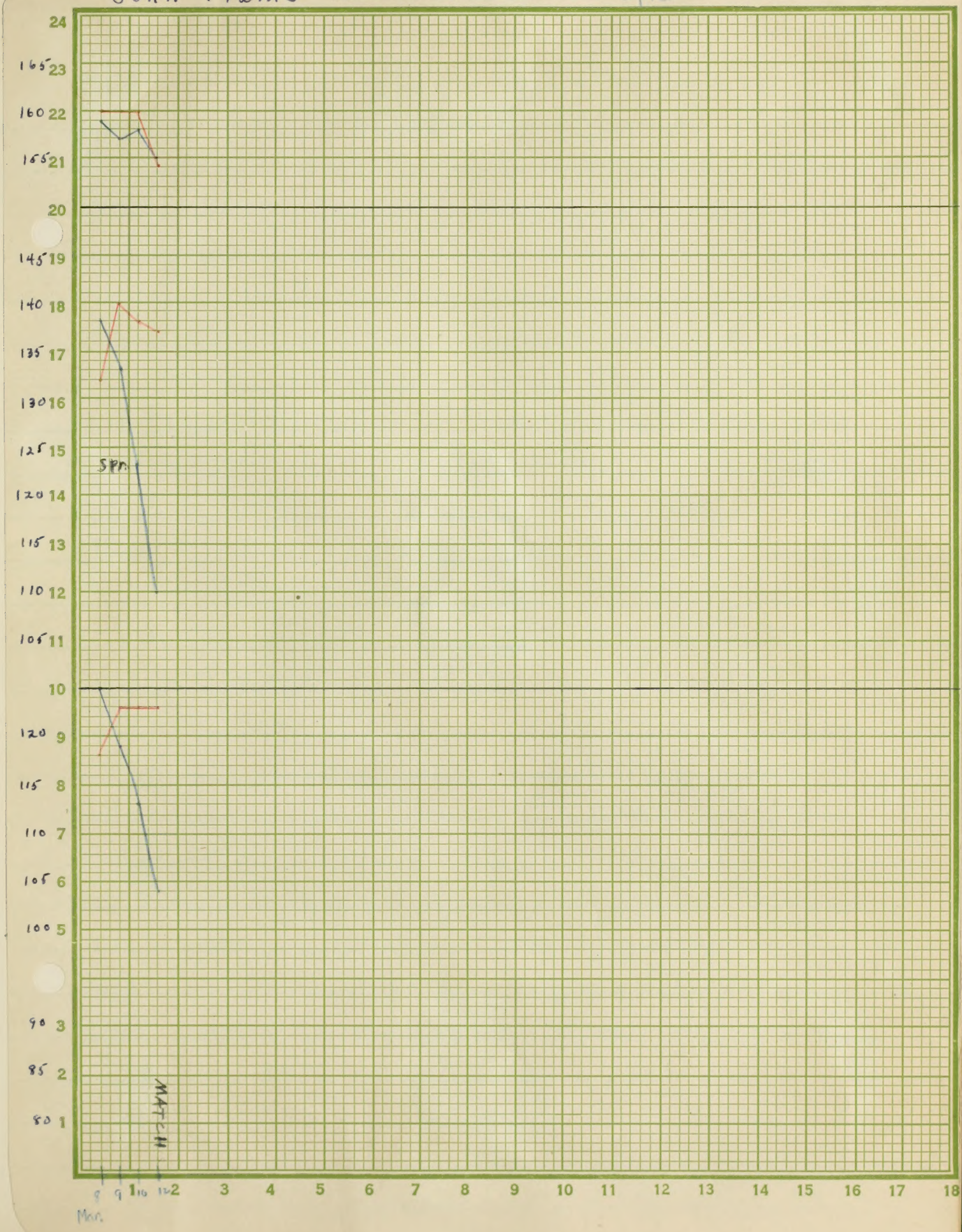
CHART II

– before
– after



John Frame CHART II--CONTINUED

– before
– after



While this condition was noted in grip strength deviations, the weight graph follows along a normal pattern. Throughout the season loss of grip strength during matches was very great, indicating that the very strenuous program of study and activities was taking its toll on a lessened physical reserve. Following these matches subject F would appear exhausted, for will power and intelligence more than strength carried him through the matches. After the sixth week, due to a combination of a slight injury, and indications of general "staleness" coming on, which was noted in declining grip strength earlier than by any other signs, the coach greatly lightened up on F's program for nearly three weeks. During that time he did not wrestle any matches, and many days he did not work out at all. This change in program made it possible for the man to wrestle the final two matches of the season, though his losses in grip strength on the last match was very large. These changing conditions were readily noted by following the grip strength graphs, but weight did not seem sensitive enough to discern them at all.

Subject Sh (Chart III on page 46) This subject was twenty-two years of age, a right hander, second year on the squad. He is a quick, wiry little fellow, who is very strong, P.F.I. 166. His weight was 115 on the first and last days of practice and ranged between 113 and 118. He wrestled in the 118 pound class, so never had to reduce to make weight. Through the first six weeks he was a very successful wrestler. About the seventh week his grip strength began to fall, though his weight remained steady.

George Shiroma

46

CHART III — before — after

He seemed to lose his speed and aggressiveness and consequently did not do as well in match competition. He began to complain of being overtired, and a cold came on. He stayed away from practice for a week to get rid of the cold, and when he returned his grip strength was still low and decreased tremendously during a workout. He was then beaten in a tryout match for his place on the team and did not wrestle any more varsity matches.

Subject Bu (Chart IV on page 48) This subject is twenty-four years of age, a natural right hander, second year on the squad. He is a big, strong athletic type of fellow, with fair co-ordination and unusually serious about anything he does. He was a willing worker, with a tendency to work too hard. He took a normal academic program and worked twenty-five to thirty hours a week in the college cafateria as a dish washer. Looking over his graph, one notes that during the first week, though his grip scores were up well before practice, they took some tremendous falls after practices and matches. At that time Bu had a cold which evidently did not affect his vigor much until strenuous exercise broke down his resistence to fatigue. On January 20th Bu made a surprisingly high score with his left grip. Repetition of the test produced the same results. Upon being questioned the subject said he had recovered from the cold, that he had taken a light workout, and was feeling more fit than he had for some time. During the sixth week he began to lose in grip strength again, and moved by that warning he began to take easier workouts, and his grip strength rise was accompanied by better performances in his succeeding matches.

Frank Butler

48
CHART IV

– before
– after

Other case studies could be reported, but the above four are typical of the results noted. Whenever grip strength started to decline or to show great losses following exercise, despite the fact that weight losses were negligible, men soon lost their speed and aggressiveness, which was usually restored by a short rest. There is little doubt but that these men were in the early stages of staleness, that if heavy work had continued a weight decline would have followed; but because of the grip strength indications most of the men were treated in time to retain a good condition.

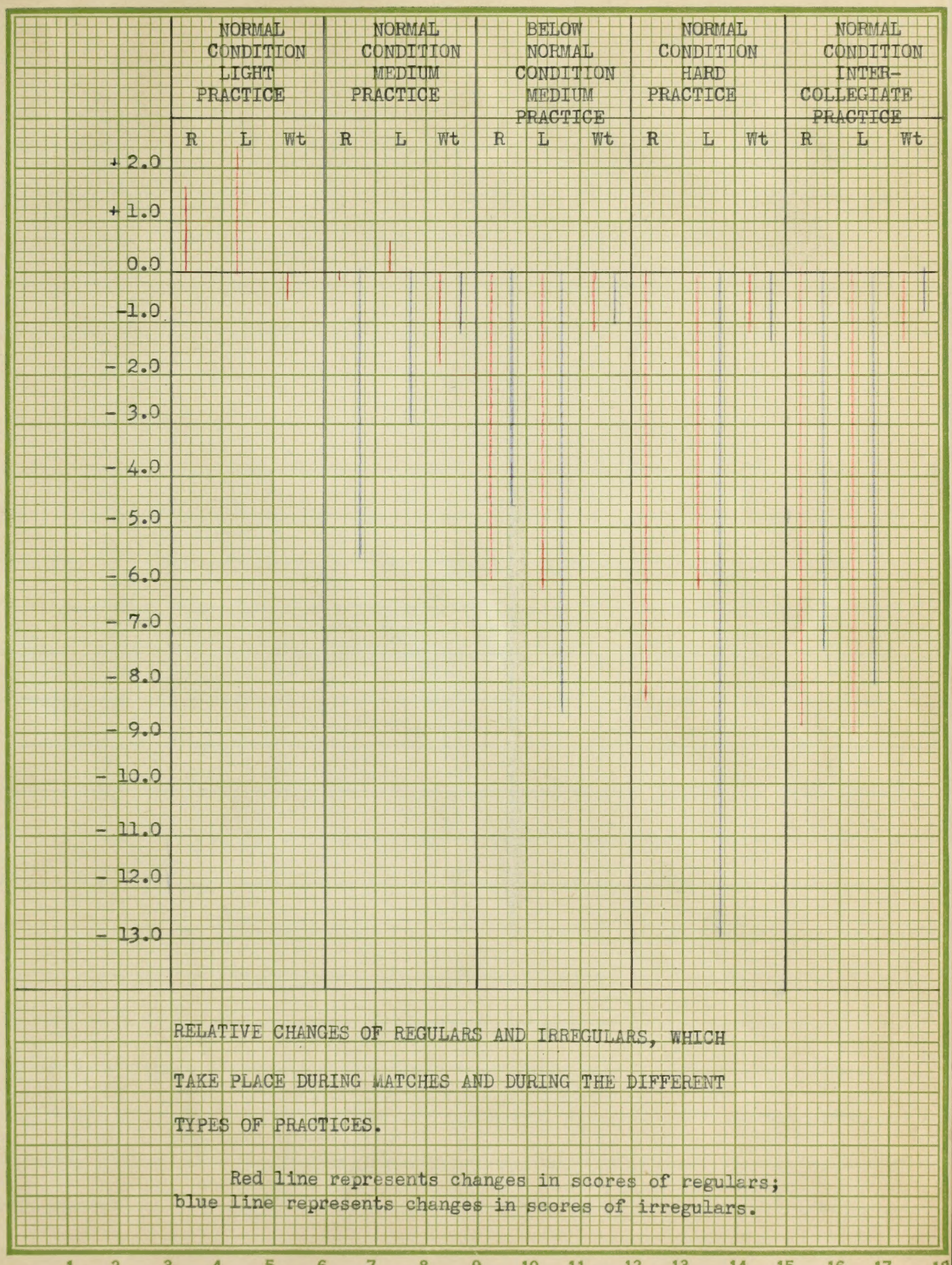
Summary of Effects of Matches and Different Types of Practice

Table X on page 51 gives a composite picture of the relative changes of the two groups which take place during matches and during the different types of practices.

Chart V on page 50 pictures the same changes in a different way. Since there is a general rule that a man normally grips one pound for each pound of body weight, and since left grip is normally not over five per cent less; it seems fair to put all three on the same chart for comparative purposes.

In general, with men participating regularly, grip strength is stimulated during a light practice, remains approximately the same during a medium practice, decreases with a hard practice, and decreases still more during an intercollegiate match. The same group, on days when physiological disturbances are evident, lose grip strength noticeably during a medium practice, though they do not lose in grip strength with the same type of practice while in normal physical condition.

CHART V



RELATIVE CHANGES OF REGULARS AND IRREGULARS, WHICH TAKE PLACE DURING MATCHES AND DURING THE DIFFERENT TYPES OF PRACTICES.

Red line represents changes in scores of regulars; blue line represents changes in scores of irregulars.

TABLE X

A STUDY OF CHANGES IN WEIGHT AND GRIP STRENGTH DURING MATCHES AND DIFFERENT TYPES OF PRACTICES

	Average changes of nine regular participants			Average changes of fourteen irregular participants		
	Right grip	Left grip	Weight	Right grip	Left grip	Weight
Normal physical condition, light practice	+ 1.55	+ 2.33	- .69	*---	*---	*---
Normal physical condition, medium practice	- .21	- .30	- 1.82	- 5.54	- 2.96	- 1.10
Below normal physical condition, medium practice	- 5.92	- 6.20	- 1.14	- 4.69	- 8.54	- 1.00
Normal physical condition, hard practice	- 8.4	- 6.22	- 1.15	- 13.05	-12.27	- 1.43
Normal physical condition, matches	- 8.87	- 8.92	- 1.39	- 7.38	- 8.00	- .87

*None of this group took light practice. When they reported the workouts were not light, at least for this physical condition.

TABLE X

A STUDY OF CHANGES IN WEIGHT AND GRIP STRENGTH DURING MATCHES AND DIFFERENT TIMES OF PRACTICE

	Average changes of nine regular workdays			Average changes of fourteen irregular workdays		
	Right grip	Left grip	Weight	Right grip	Left grip	Weight
Normal physical condition. Light practice	+ 1.55	+ 2.33	- .69	*___	*___	*___
Normal physical condition. Medium practice	- .21	- .30	- 1.82	- 5.54	- 2.96	- 1.10
Below normal physical condition. Medium practice	- 5.92	- 6.20	- 1.14	- 4.69	- 8.34	- 1.00
Normal physical condition. Hard practice	- 8.4	- 6.22	- 1.15	- 15.05	-12.27	- 1.43
Normal physical condition. Matches	- 8.87	- 8.92	- 1.39	- 7.38	- 8.00	- .67

*None of this group took light practice. When they reported the workouts were not light, at least for this physical condition.

With men participating irregularly there is a noticeable loss in grip strength during a medium practice. The loss is greater during hard practices. Though the loss during matches is not as great as during hard practices, the relatively short average duration of matches for this group, 6.14 minutes, accounts for this lower degree of loss. The same group, on days when they reported in physical condition below par, showed a greater loss during a medium practice than the regular participants during the same type of practice.

Weight deviations were fairly constant during the different types of conditions, and showed no relationship to fatigue factors.

CHAPTER III

The Effects of Intercollegiate Match Factors on Grip Strength and Weight

Several factors associated with intercollegiate matches would not be evident to any great degree in the ordinary practice periods.

One of the most important of these is an emotional "keying-up process", which competition naturally stimulates. Crowds, publicity, and awards, traditionally associated with college athletics, add further to this stimulus. Some coaches play upon this factor to secure immediate results in the form of wins, while others believe that over a period of time this method not only loses its effectiveness, but that energy spent under such condition cannot be easily reclaimed, and that health, so essential to success in life, should be conserved in school boys rather than dissipated. Coleman R. Griffith, associate Professor of Educational Psychology at the University of Illinois, has for several years been making special studies of psychological problems in the field of athletics; and he has much to say about the evils of keying up the emotions of boys in athletics.[1] The coach of the wrestling squad used as subjects in this study was of the latter type so that the emotional factor would not be as great on this squad as it might be in some groups. However, winning wrestling teams were a tradition in the school and large crowds attended the matches, so that the men were competing under pressure. Awards were given, but on a modest basis compared with the general practice in college ranks of today.

Another factor would be the weight changes accompanying match competition. Intercollegiate wrestling is organized on a weight classification basis. It is common practice for a man a few pounds over the maximum limits of a

[1] Coleman R. Griffith, The Psychology of Coaching, New York: Chas. Scribner's Sons, 1932, pp. 87-89.

weight division to train down for the lower division rather than wrestle in a higher division. Within five hours of a match a man must make weight. Between the weighing in period and match time he is allowed to take on as much weight as he desires or is able to. In the groups included in this study, five of the nine regular and five of the fourteen irregular participants normally weighed over the limits of the division in which they usually wrestled. Weight was taken off by careful diet, drinking less liquid the last twenty-four hours before a match, and by sweating. Immediately after weighing in, five hours before a match, each man was given a steak dinner, which was his last meal before the match. Some of the men took off weight gradually, while others depended upon the last twenty-four hours to eliminate any surplus.

For purposes of comparison individual and group averages are compiled for right and left grip strength and for weight just prior to last practice before a match; scores recorded at the weighing in period; just before the match; just after the match; and just prior to the next practice after the match. Group and individual deviations are noted from the normal averages of each of these. While the principle is recognized that a normal average does not represent an ideal, it makes a convenient and understandable norm.

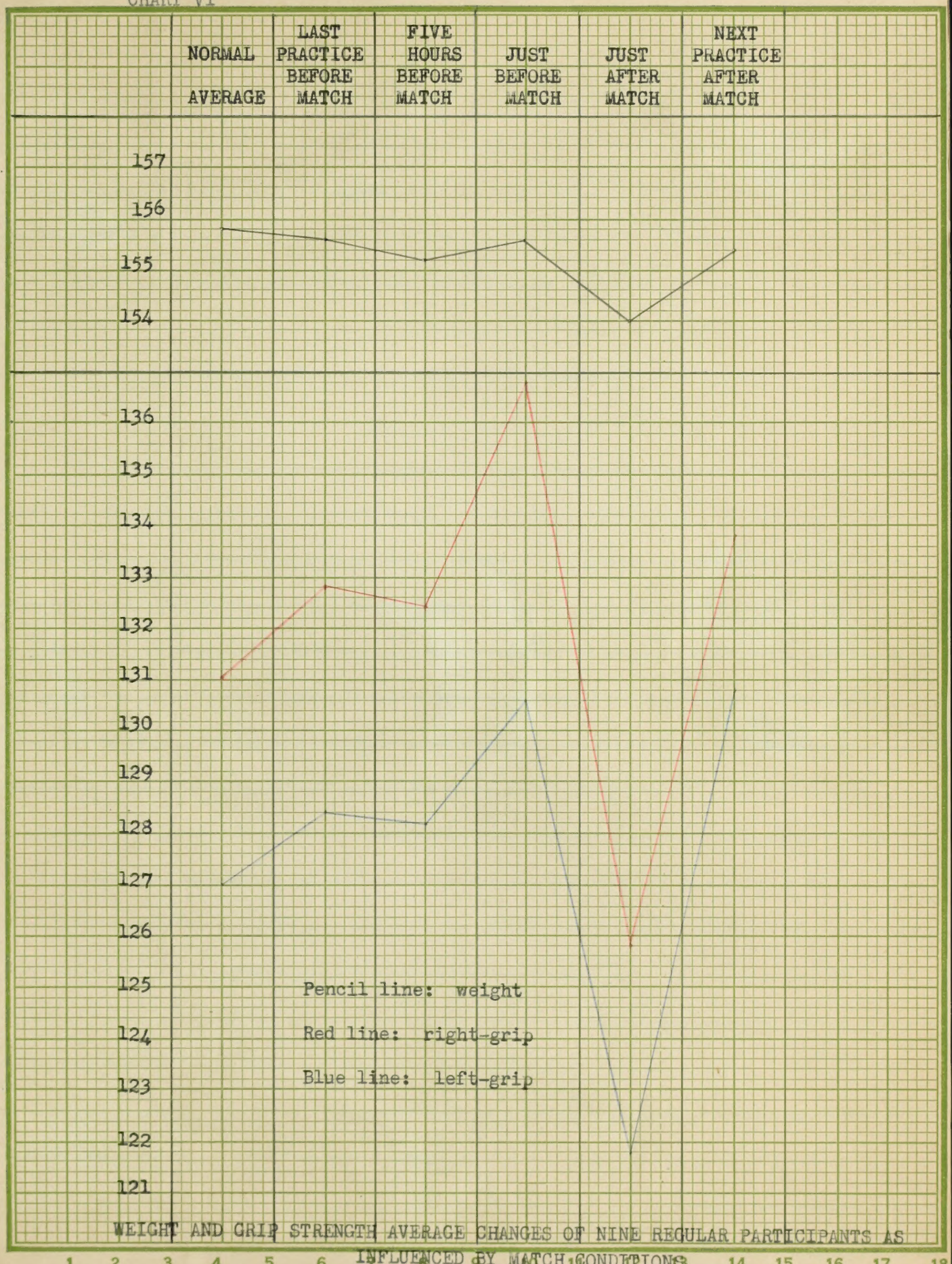
Ideally the first column should show scores the day before the match in each of these cases. However, sometimes the squad or some individuals took a complete rest on that day, in which cases scores were taken from the preceding day's record. Also it would have been well to have columns of scores from the first day and from the second day after a match in order to have recorded more accurately the time needed to recover normal grip strength in each case. However, several of the matches were held on Saturday evening, in which case the squad did not meet for practice until Monday. Further it was not unusual following a hard match for men to take a day or even two days layoff in order

to fully recover powers, or to prevent "staleness". Evidence indicates that this was a worthwhile policy.

Chart VI on the following page graphically pictures weight and grip strength average changes of the group of nine regular participants as influenced by match conditions. The first point indicates the normal; the second, just prior to the last practice before a match; the third, the weighing-in period; the fourth, just before the match; the fifth, just after the match; and the sixth, just prior to the next practice after the match. As noted on the chart, the lead pencil represents weight; the red line, right grip; and the blue line, left grip.

A study of this chart will show that right and left grip strength follows an almost identical pattern. Starting from a normal average, there is a slight rise in the averages of scores taken preceding the last practices before matches. This is probably due to a more careful observance of training rules pertaining to diet and sleep as the time of a match drawa near. The averages of the scores taken at the time of weighing in, five hours before the match, show a slight decline, though they are so small as to be relatively insignificant. This might be due to the effort to take off the last bit of excess weight. The next point, just before matches, takes grip strength averages to the peak, a relatively large increase. Probably the steak dinners helped some but this climb within a space of five hours is, in all probability, due mostly to a "keying" up of the emotions. From these high peaks reached just before the matches, grip strength averages take a plunge to the low points just after the matches. Real fatigue from the mental and physical strain of match competition together with an emotional letdown seem to reasonably account for this change. Then comes another rise to the point representing the averages of scores taken just before the first

CHART VI



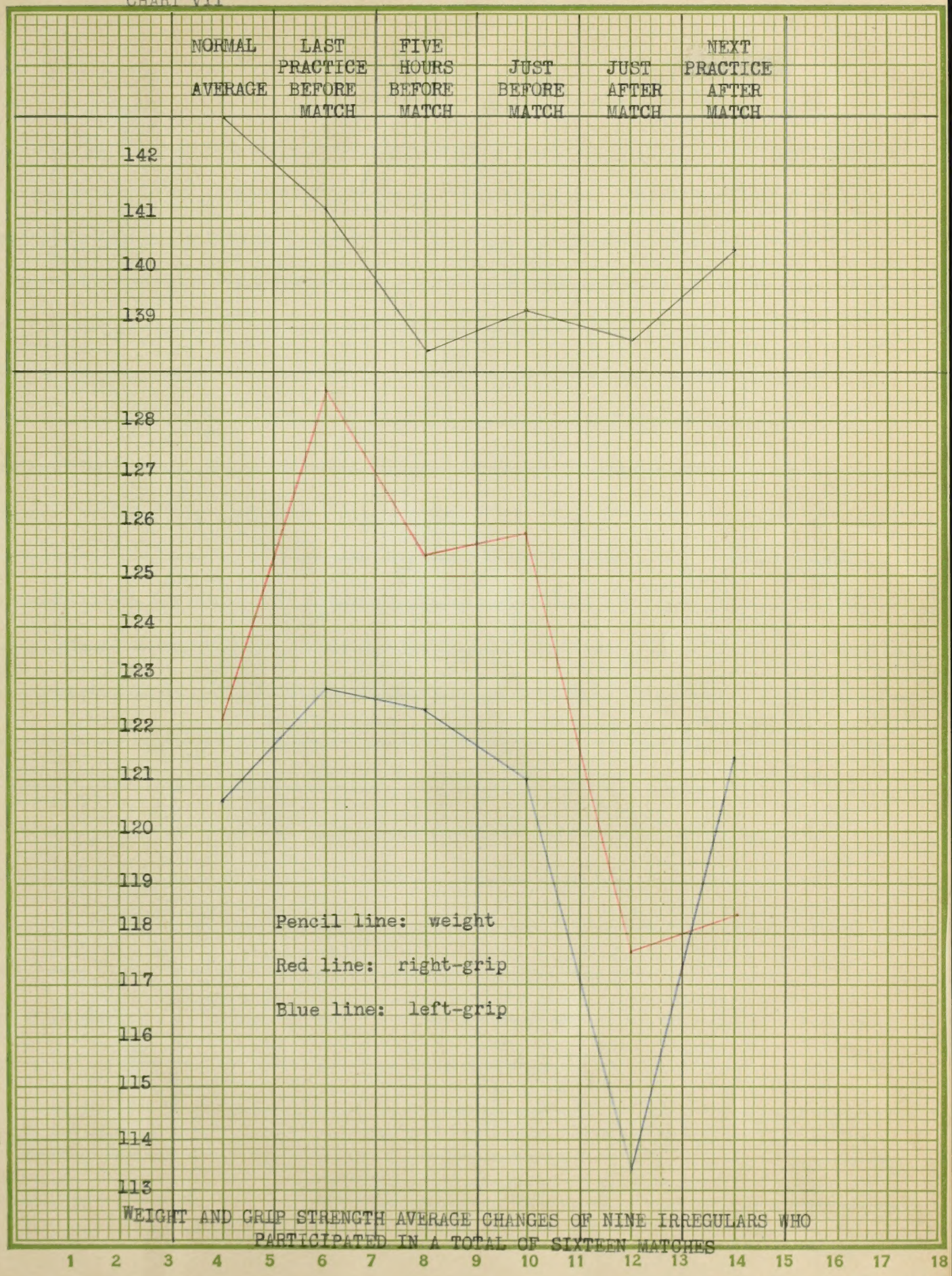
WEIGHT AND GRIP STRENGTH AVERAGE CHANGES OF NINE REGULAR PARTICIPANTS AS INFLUENCED BY MATCH CONDITIONS

practice following matches. In the right grip, the rise is moderately high; in the left grip it is very high. Since we are dealing with well conditioned athletes, a return to normal should be expected, but it is surprising to see that rise in the two days following competition. The only plausible explanation is that the coach's policy of permitting the men a good rest before resuming practice paid good dividends in bringing them to a high degree of physical efficiency.

Looking at the weight line, one can see a slight drop from the normal average to the point representing average weight scores the last practice preceding a match. This is due to the practice of most of the men of taking off weight gradually rather than waiting until the last twenty-four hours. It will be noted that during this decline in weight there is a comparative rise in grip strength averages, indicating that a loss in weight, up to a certain point at least, does not indicate a loss in physical vigor. At the next point, weighing in period, the slight decline in weight corresponds to the slight losses in grip strength, adding evidence to the suggestion that the effort of losing the last pounds is accompanied by a loss in physical vigor. An analysis of individual tables shown later further substantiates this. An average rise of four-tenths of a pound in the next five hours can be attributed to the meal. Logically the line falls to a low point as weight is sweat off during the match. Resumption of normal eating and living habits brings the weight average practically back to the normal before the next practice. The weight line does not accompany the grip strength lines in their rise above normal.

Chart VII on the following page graphically pictures weight and grip strength average changes of group of nine irregulars who participated in a total of sixteen matches. The comparatively small number of matches involved make the chart less significant than Chart I, but does indicate something in the way

CHART VII



WEIGHT AND GRIP STRENGTH AVERAGE CHANGES OF NINE IRREGULARS WHO PARTICIPATED IN A TOTAL OF SIXTEEN MATCHES

of trends. Glancing first at the lead weight line, one can see that this group, like the regular group, had taken off some weight prior to the last practice before matches. At the same time, as with the regulars , grip strength went up, right grip taking an even greater rise. This would add further evidence to indicate that an increase in physical rigor may accompany a loss of weight up to a certain point. Following the lines to the weighing in period, one can see that the irregulars took off a greater amount of weight during the last twenty-four hours than the regulars, and that grip strength took a slightly greater fall. During the five-hour period before match time the weight lines of the two groups correspond, but whereas the regulars take a decided rise in grip strength, the irregulars take a slight rise in right grip and a slight decline in left grip. The only accounting for this seems to be that, despite the emotional factor, these men are not conditioned to the point that they have a physical reserve which they can call upon when desired. The declines during matches correspond fairly well, though with the regulars the loss is somewhat greater, and with the left grip the decline of the irregulars is slightly greater. In the "comeback" period, between the match and the next practice, one finds quite a difference between charts I and II. The regulars make an almost complete recovery of weight, but the irregulars average nearly two points short of a return to normal. The rest period brings the right grip of the regulars to an average of nearly three points above normal, but the irregulars, despite some comeback, remain nearly four points below normal. The regulars have a rise of nearly four points above normal in left grip, while the superior condition of the regulars, due to a greater regularity at practice, makes possible a speedier recovery of powers, following a period of unusual fatigue. Tables XI, XII, and XIII on pages 60, 61, and 62 list individual changes in right grip, left grip, and weight of the regular participants during the five testing periods

Table XI

CHANGES FROM A NORM OF RIGHT GRIP SCORES OF REGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal averages	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Be*	153.89	- .39	+ 4.11	+ 3.29	- 3.34	+ 4.00
Bu	147.39	+ 4.05	+ 3.47	+ 3.70	-11.30	+ 1.61
E*	114.29	- 2.29	+ 3.71	+ 8.71	- 4.29	+ 2.81
F*	138.67	+ .83	- 5.67	+ 5.93	- 7.07	+2.33
He*	110.86	+ 1.64	+ .84	+ 1.64	- 5.06	+ 1.94
Ha	143.07	+ 1.73	- 4.77	- 1.67	- 6.27	+ 1.22
Sc	143.37	+ 1.23	- 1.07	+ 3.83	- 6.37	- 2.87
Sh	122.25	+ 5.25	+ .75	+ 5.32	- 3.25	+ 4.04
P*	111.24	- 1.64	- 4.40	+ 1.46	- 4.14	+ .98

* Indicates men who took off weight to keep within limits of weight division.

Table XII

CHANGES FROM A NORM OF LEFT GRIP SCORES OF REGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal averages	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Be*	164.05	+ .58	+ 2.52	+ 2.86	- 7.50	+ 4.06
Bu	147-00	even	+ 3.00	+ 3.14	-14.34	+ .33
E*	117.12	+ 2.88	+ 3.88	+12.88	- 9.12	- 3.12#
F*	123.08	- 3.48	- 4.08	- 1.28	-14.08	+ 4.25
He*	101.73	- .63	+ 1.67	+ 2.47	- 3.38	+ 2.77
Ha	143.07	- .27	- 3.07	+ 4.43	- 7.57	+ 4.26
Sc	135.42	+ 2.18	+ 3.58	+ 2.08	- .67	+ 3.08
Sh	116.25	- 2.25	+ 5.08	+ 7.89	- 3.68	+ 4.18
P*	105.80	+ 1.70	- 4.70	+ .50	- 1.70	+ 2.20

* Indicates men who took off weight to keep within limits of weight division.

Injured left shoulder.

TABLE XIII

CHANGES FROM A NORM OF WEIGHT SCORES OF REGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal average	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Be*	169.00	- .13	- 4.00	- 2.14	- 3.55	- .67
Bu	174.44	- .11	- 1.80	- 2.08	- 3.61	+ .23
E*	121.39	+ .61	- 3.39	- 2.39	- 3.89	+ 3.61
F*	160.08	- 1.58	- 5.58	- 3.98	- 5.28	- .08
He*	129.27	- .37	- 2.57	- 1.67	- 2.87	- .27
Ha	199.51	+ .49	- 2.21	- 2.21	- 2.41	- .94
Sc	183.16	- .06	- .66	- .66	- 3.83	- .16
Sh	116.25	+ .58	- 1.08	- 1.08	- 2.11	- .82
P*	149.95	- 1.75	- 3.95	- 3.95	- 3.05	- .62

* Indicates men who took off weight to keep within limits of weight division.

most affected by intercollegiate match factors. The first column in each case lists the subjects with stars for those who usually were obliged to take off weight for matches. The next column gives normal averages, and then follow in chronological order deviations from the normal average which are revealed by testing prior to the last practice before a match; at the weighing in period, just before the matches; just after the matches; and just prior to the next practice after matches.

Beginning with the deviations recorded prior to the last practice before matches, a brief analysis will be made of each column for each table.

In the column of scores recorded prior to the last practices before matches there does not seem to be much of great significance. Of the five men who were obliged to take off weight for matches, four had already shown decreases, as one showed a very slight decrease. Of the four men not obliged to take off weight, two showed slight decreases and two slight increases. There seems to be little, if any, correlation between changes in weight and changes in grip strength as far as individuals are concerned.

At the weighing-in period all nine men were below normal weight. Five, of course, had taken weight off deliberately, but the other four must have gone down naturally as a result of a lighter diet preceding competitive matches. Five of the nine increased in both right and left grip, while one subject, Sc, decreased in right and increased in left. Three subjects, F. Ha, and P, decreased in both right and left grip strength as well as in the weight. F was obliged to take off more pounds than any other regular in order to make weight; and P, with the exception of one match, when he wrestled in a higher weight division, rated second in number of pounds to take off. Neither could eat anything for a period of twenty-four hours before weighing in. Without doubt

this lack of food weakened them. Sc, however, was not obliged to take off weight, and there seems to be no known reason, as yet, for his loss in grip strength.

Just before the matches there is a much greater degree of uniformity in the group. Every man, though up in weight from the weighing-in period, was still below normal. In right grip scores all are above normal except Ha, whose left grip, however, brings his total grip strength average above normal. In left grip scores F is the only exception, and his right grip likewise brings the total average above normal. There seems to be no accounting for these two exceptions.

Just after the matches every man except P reached his lowest point in both right and left grips. P. though below normal in each, did not get back to his low level, reached at the weighing in period, in right grip, left grip, nor weight. Evidently the effort to get down to weight took more out of him than the match itself. If this conclusion is true, he might well have been more successful wrestling in a higher weight division. He did wrestle one match in the higher division and pinned his man quickly. It should be added here that this subject was the most experienced wrestler on the team and just prior to matches had the least total strength score above normal of any of the group, which would indicate less effect from the emotional factor. Being less "keyed up" emotionally before the match, it is not surprising that his drop after the match was not as great as the others. Two other men, Be and F, did not quite reach their lowest level in weight. Each had taken off considerable weight to meet the requirements of their respective divisions, and each had regained over a pound and a half before match time, so the fact that they did not sweat off more than this in a few minutes of wrestling is not startling.

Scores taken the next practice after matches again show very few exceptions

to the general trend. Table XI on the following page shows a return of all subjects back above normal in right grip except subject Sc. However, his left grip score makes up for this so that his total grip score average is slightly above normal.

Table XII on the following page shows all subjects back above normal except C. A recheck on the reasons for this revealed an injured left shoulder, which would account for this deviation from the normal trend. Table XIII shows that seven subjects were back nearly to normal weight, Bu slightly over normal weight, and E well over normal weight. The figures in this column would indicate that all subjects in this group were well conditioned and had a rapid recovery of physical powers following excessive fatigue.

Tables XIV, XV, and XVI on pages 66,67 , and 68are similar to tables XI, XII, and XIII, except that they give scores and deviations of the irregular participants rather than the regulars.

A study of the columns of deviations noted prior to the last practices before matches shows that four of the five men who were obliged to take off weight had begun to do so. The fifth man was just normal in weight. Grip strength averages of this group of five show nine above normal and one just normal. This adds further evidence to prove that loss in weight up to a certain point contributes to physical vigor. Three of the other four men show a gain inweight and one a loss. One of this group shows a gain in both grips, while the rest show a gain in one and a loss in the other.

The next column shows a very little correlation between grip strength and weight changes. Several of these subjects participated in but one match, and there is too little data to account for the deviations with any degree of certainty.

Table XIV

CHANGES FROM A NORM OF RIGHT GRIP SCORES OF IRREGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal average	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Ba	95.00	+ 5.00	+ 2.50	+14.50	+ 1.00	- 5.00
C	136.53	-16.53	+ 1.53	- 6.53	-17.53	- .53
D	120.00	+ 5.00	even	+ 2.50	-16.50	- 2.00
La*	125.00	+11.00	+ 3.00	+ 6.00	+ 4.00	+ 6.50
Ll	135.78	+ 4.22	-11.78	-13.78	- 7.78	+ 2.22
M*	106.38	+ 4.62	- 5.88	+ 1.22	- 3.38	- 5.78
R*	108.00	+ 2.00	no scores	+22.00	+ 2.00	+ 4.00
Schn*	133.33	+ 2.67	- 7.33	- 3.83	- 3.33	- 3.33
T*	140.00	+40.00	+20.00	+10.00	even	even

* Indicates men who took off weight to keep within limits of weight division.

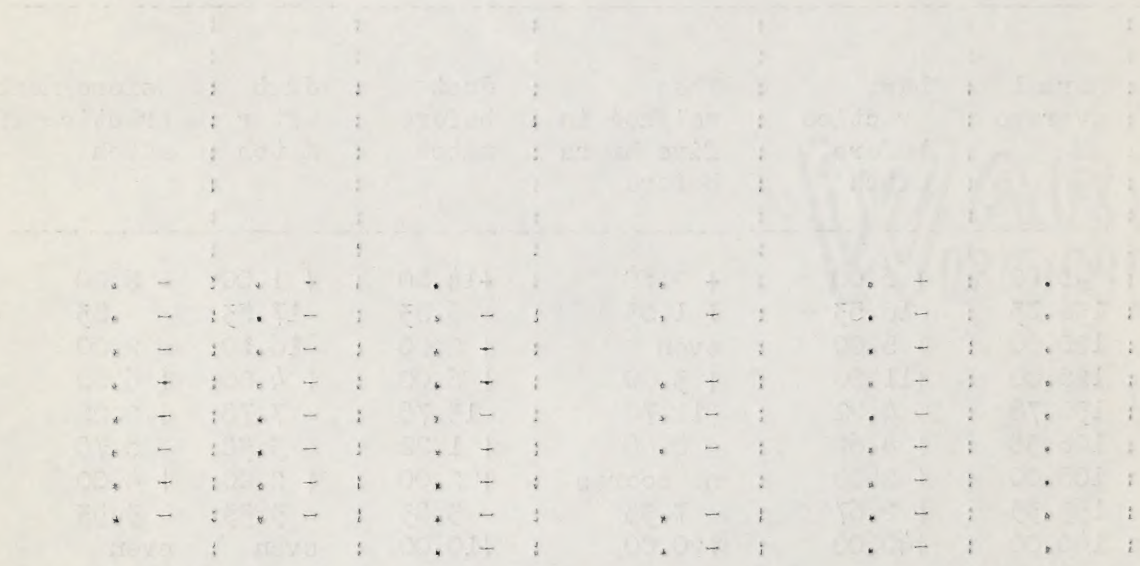


Table XV

CHANGES FROM A NORM OF LEFT GRIP SCORES OF IRREGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal average	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Ba	114.50	- 4.50	- 4.50	- 5.50	- 7.00	+ 4.50
C	127.00	+ 1.00	- 6.00	- 8.00	- 11.00	+ 2.00
D	106.25	+ 8.25	+10.25	+11.75	- 8.25	+ 2.25
La*	121.25	+ 9.75	+.6.25	+12.75	+ 5.25	- 1.25
Ll	120.78	- 2.78	-10.78	- .78	- 4.78	- .78
M*	130.00	+ 1.50	- 9.50	- 2.00	-11.75	- 6.20
R*	99.00	+ 1.00	-----	- 1.00	+ 1.00	- 5.00
Schn*	126.00	+ 6.50	- 2.50	- 3.50	- 8.50	- 4.00
T*	140.00	even	+10.00	even	-20.00	even

* Indicates men who took off weight to keep within limits of weight division.

Table XVI

CHANGES FROM A NORM OF WEIGHT SCORES OF IRREGULAR PARTICIPANTS AS AFFECTED BY INTERCOLLEGIATE MATCH FACTORS

Subjects	Normal average	Last practice before match	When weighed in five hours before	Just before match	Just after match	Before next practice after match
Ba	131.50	+ 1.50	+ .50	- .50	- 1.75	+ .50
C	159.00	-11.00	- 7.00	- 7.50	-10.00	- 6.00
D	131.17	+ .33	- 3.67	- 4.67	- 5.17	- 2.67
La*	145.50	- .50	- 7.00	- 5.00	- 6.50	- 5.00
Ll	149.89	+ .11	+ .11	- 3.39	- 1.89	+ .11
M*	139.50	- .50	- 4.50	- 1.20	- 2.50	- .10
R*	141.00	even	-----	- 2.00	- 2.00	- 1.00
Schn*	123.67	- .17	- 5.67	- 1.92	- 1.67	+ 1.33
T*	166.00	- 6.00	-12.00	- 8.00	- 9.00	even

* Indicates men who took off weight to keep within limits of weight division.

Just before the matches the five men who were forced to take off weight had partially, though not completely, recovered it; while the other four were lower in weight than they were five hours earlier. Each of the five made weight with great difficulty, and after a starvation period, evidently relished their food and quickly recovered some of the lost weight. The other four must have been affected by nervousness or other factors which prevented them from enjoying their food and eating well. Subject Ba is an extremely nervous type the day of the match. Subject C participated in but one match, an out-of-town match requiring an early start and a round trip travel by car of over three hundred miles. Another factor was that it turned out to be a warm, muggy day, and the scores of all men on that trip were, with very few exceptions generally down. Subject C went steadily down in grip strength and weight with each successive test. Subject D is apparently a phlegmatic type, and there is no accounting for his loss in weight during this period. However, he did increase in both right and left grip strength. Subject Ll lost in right grips and weight. He was apparently nervous to the point where it sapped his vitality.

Just after the match there are very few exceptions to the downward trend. All men lost weight during the match. Subject La, though losing in both grips, was still above his own normal in each. One of his two matches terminated in a fall in four minutes and twenty-eight seconds, and in the other match, both men were on their feet much of the time, and there was little actual wrestling on the mat. Careful observation throughout the season indicated clearly that matches in which men went to the mat quickly and spent most of the time actually wrestling took much more vitality out of the men than matches in which there was much sparring around, but little actual wrestling. Other deviations from the general trend are so minor that they hardly need explanation.

The most significant point in the last column is that men who were obliged to take off weight show a slower recovery of both grip strength and weight. As Chart VII on page 58 also shows, the general recovery of weight and grip strength is slower with this group than with the regular participants, indicating a generally poorer physical condition.

Summary of Effects of Intercollegiate Match Factors on Grip Strength and Weight

Loss of weight in well-conditioned athletes up to a certain point for each individual is accompanied by a rise in grip strength, and therefore probably by a rise in physical powers. The effort to reduce weight beyond this point weakens the body and is reflected in a loss of grip strength. Food, which helps to restore some weight, also helps bring back strength.

Before intercollegiate competition there is an emotional factor, which stimulates grip strength to a high peak, which following a few minutes of wrestling descends to a very low level. This decline is due at least partially to an emotional let down, from a keyed up condition since a greater amount of wrestling in a practice session does not result in as great a loss.

Even though suffering a great loss in grip strength during a match, a well conditioned athlete will regain his normal powers within at least forty-eight hours. Athletes not so regular in practice and thus not so well conditioned recover powers more slowly.

Weight is not sensitive to a heightening powers due to emotional stimulus, nor to fatigue from either an emotional let down or from a more strenuous match. Changing weight over a short span of time is indicative of little except a loss or intake of water.

CHAPTER IV

General Effects of Daily Practice of Athletics

Football

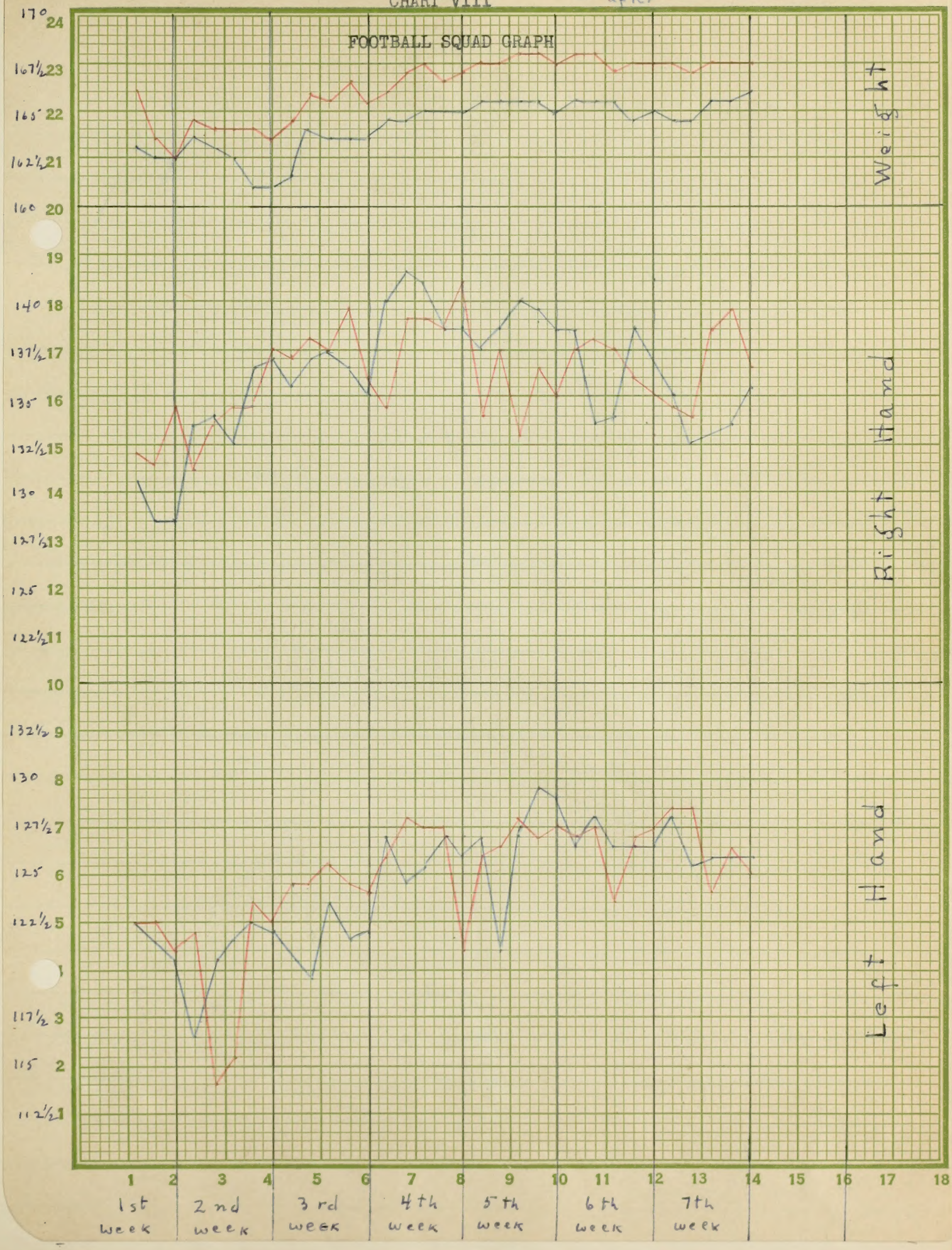
As has been previously stated, weight and grip strength records were kept for the varsity football squad. Individual graphs were carefully kept, but a check on daily activity habits was not kept closely enough to make possible a careful analysis of these individual graphs.

ChartVIII on page 72 is a squad graph made up from averages of scores taken from the indiviudal graphs and is included because a few general conclusions may be drawn.

It is a generally accepted theory that the average squad takes off weight during the first few days of practice, then steadily gains weight for a few weeks, and in the latter part of the season regains weight built up. Weight lost early in the season is excess fat, and weight taken on during the season is muscle tissue. A squad which follows this general pattern should be a well-conditioned squad. ChartVIII on the following page shows that the varsity squad studied in this research did follow this pattern, and thus we might conclude that general fitness was reflected by the squad-weight graph. It is also very significant that the grip-strength graphs also followed this general pattern, though on certain days much greater deviations were recorded. This would contribute evidence to the conclusion that while changes in weight do indicate general changes in condition over a period of time, changes in grip strength do likewise and are more sensitive to minor changes.

CHART VIII

– before
– after



It is interesting to note that with very few exceptions the average squad weight was consistently four or five pounds less after practice than before; whereas grip strength changes fluctuated considerably, and in many instances scores were higher after practice than before. These latter results were discussed with the men, and the general opinion was, that after sitting in classes for most of the day, a moderate workout in the brisk fall air stimulated them more than it fatigued them. While sufficient data was not collected to present statistics, it was observed that on days of strenuous scrimmages the fatigue factor was reflected in a decided loss of grip strength during practice. It seems logical to assume that losses in weight during a short period are due to loss of water, and do not necessarily reflect changes in physical fitness, whereas grip strength is sensitive to a stimulated condition and to fatigue.

Basketball Squad

As has been previously stated, basketball men were tested for grip strength and weight before and after practice sessions. Conditions made it impossible to secure the same information on the evenings of regular games. Also, no accurate health logs of individuals were kept, so that it is impossible to make a worthwhile analysis of individual scores

As with other athletic squads, weight losses were consistent, the squad's average loss being 1.54 pounds. However, unlike the football squad, the basketball squad showed a tendency toward a slight loss in grip strength during practice, the squad average loss in right grip being 1.25 points and the loss in left grip being .25 points.

Summary of General Effects

From data obtained from the football squad, from the wrestling squad as reported in Chapter II, and from individual case studies reported in Chapter VI it seems evident that a college man in normal health is stimulated physically by normal participation in many different branches of athletics, and that a rise in grip strength reveals such an effect. At first glance it would seem that data obtained from the basketball squad is counter evidence. However, one familiar with the game knows that, under the 1937-38 code of rules, the game was materially speeded up by the elimination of the center jump, and that basketball, as it was played last winter, was unusually strenuous. One study[1] found that the distance traveled by a college basketball player in a game in 1938 ranged from 2.65 to 3.20 miles as contrasted with a range of 2.25 to 2.50 miles per game in 1931, which was before the inclusion of the ten second rule and the elimination of the center jump. Another study[2] gives evidence that weight loss is greater, pulse recovery slower, and systolic blood pressure recovery slower in games played under the new rules than in games played with the center jump included. These findings would indicate that basketball, as it was played last winter, was a very strenuous game, and would help to account for the loss in grip strength of college men during basketball practices. Had it been possible to check scores before and after intercollegiate games, the losses in grip strength would doubtless have been more pronounced.

[1]Fay, Paul J. and Messersmith, Lloyd L. "THE DISTANCE TRAVERSED BY COLLEGE AND HIGH SCHOOL BASKETBALL PLAYERS AND EFFECT OF RULE CHANGES UPON DISTANCE TRAVERSED IN COLLEGE GAMES", Athletic Journal, XVIII, April, 1938, 37-39.

[2]Hein, Fred V. and Randall, A. J. "EFFECTS OF THE CENTER JUMP ELIMINATION", Scholastic Coach, VII (April, 1938) 16.

CHAPTER V

Diurnal Changes in Grip Strength

Two subjects tested themselves hourly during waking hours; one for a period of twenty days, and one for a period of eleven days. A third subject started testing himself hourly, but after one day his hands became sore, so he changed to testing every two hours, and kept this up for five more days.

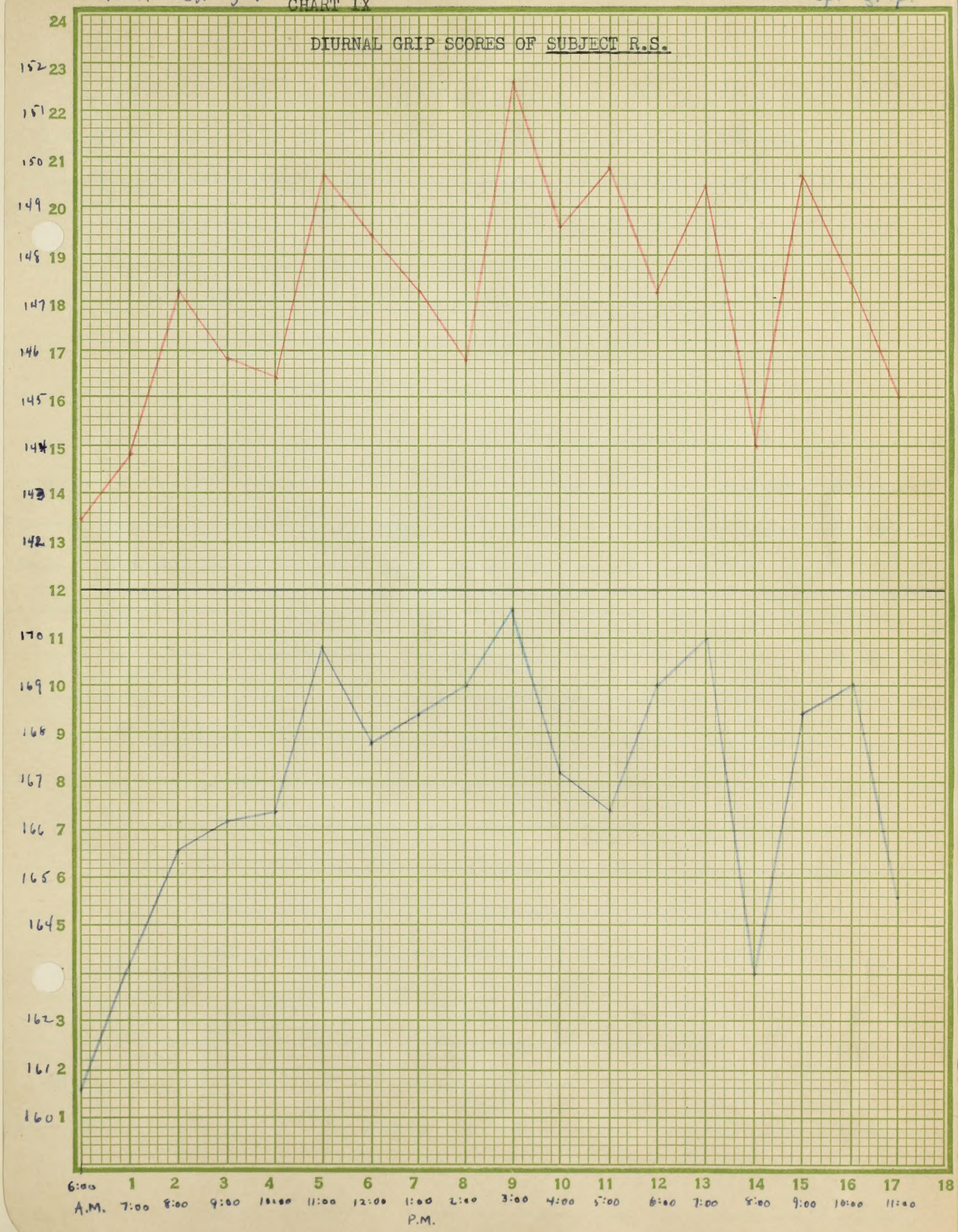
Chart IX on page 76 shows the average hourly scores of R.S., who was twenty-one years old and weighed one hundred sixty-five pounds. Scores were taken over a period of twenty days in December. He averaged six and one-half hours of sleep per night, carried sixteen academic hours, and worked about twenty-five hours each week. After February 1 he played varsity basketball, but this activity did not come within the range of this testing period. His meal hours were 7:00, 12:00, and 6:30. The subject's low point of the day, as with the other two subjects, was the first hour in the morning. Except for slight right grip declines at 9:00 and 10:00, grip strength steadily rose to a morning peak at 11:00 o'clock. At 12:00 o'clock, just before dinner, there was a loss in both grips. After dinner the right grip declined, but came back to the highest peak of the day at 3:00 P.M. After that hour, scores fluctuated until 9:00 o'clock. All scores then steadily declined through 11:00 o'clock, when the subject retired for the night.

R. K. Schlegel

CHART IX

— right grip
— left grip.

DIURNAL GRIP SCORES OF SUBJECT R.S.



On page 78 is a chart of average scores of W.G., weight one hundred ninety six pounds and age twenty-two years. He is the varsity football captain. During the testing period of eleven days in December he carried fifteen academic hours, and worked daily from 6:00 to 10:00 A.M in addition to averaging seventeen extra hours of work per week. His meal hours were 7:00, 1:30, and 6:30. Starting at the lowest point, this subject's right grip increased steadily to reach the high point of the day at 10:00 A.M. From then it fluctuated, reaching a high point of the afternoon at 3:00 o'clock. His high point of the evening for the right grip was at 7:00, and low point at 10:00, the final testing time of the day. This final score was lower than any other after 8:00 A.M. The left grip followed the same general pattern, except that the high point of the day was reached at 12:00 M. instead of 10:00 A.M.; and the afternoon high point at 2:00 instead of 3:00. Evening changes corresponded very well, with the 10:00 score reaching the lowest point since 8:00 A.M.

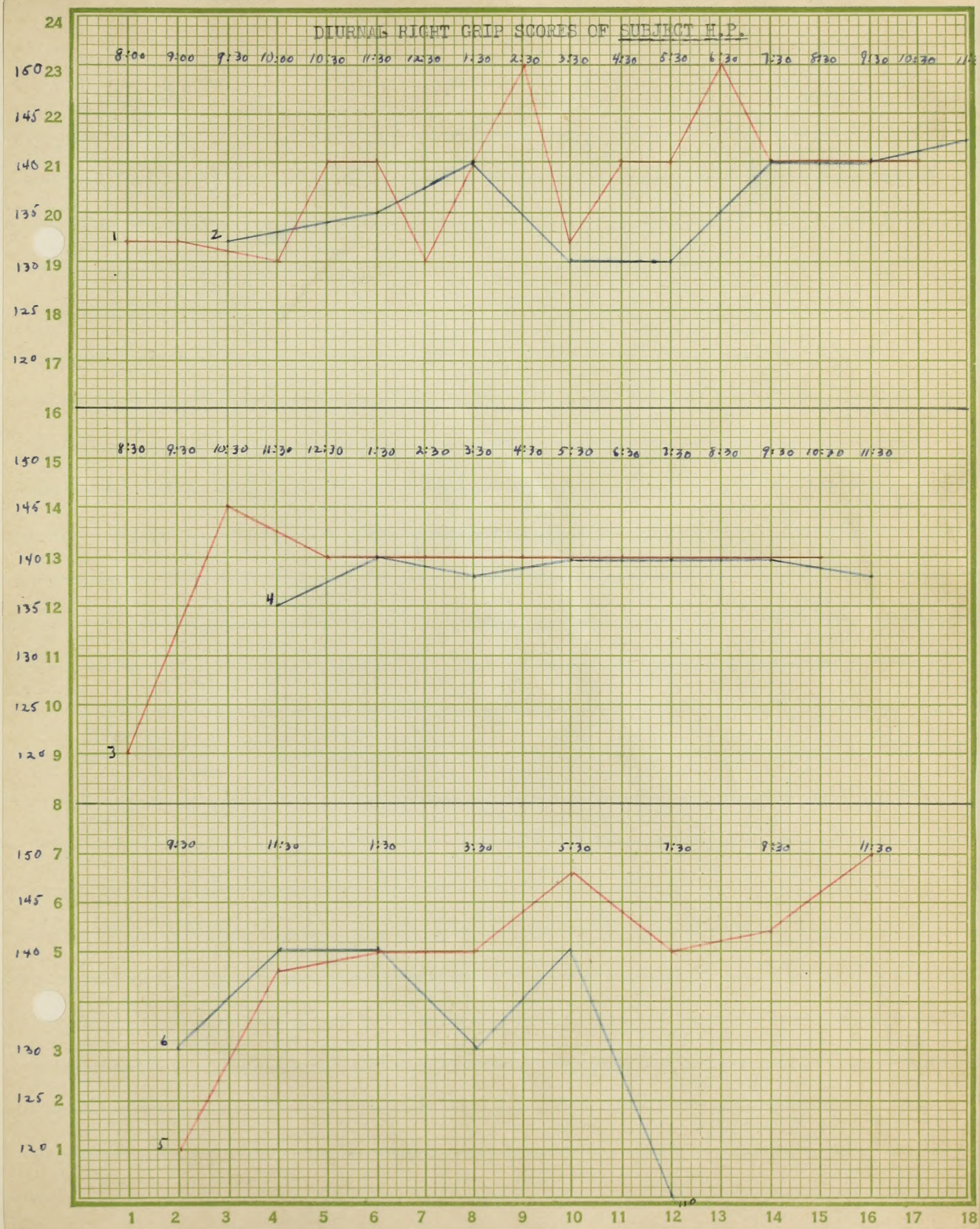
Subject H.P. was twenty-three years of age and weighed one hundred fifty pounds. He is a former track captain, and is usually very active in some form of sport; but during this testing period, March 1 to March 8, was not taking any regular exercise. He carried a normal academic program and did no outside work. He had enough sleep, eight hours or more a night, but kept no regular time for going to bed or getting up. On page 79 is a chart on which his right-grip strength scores for the six days of testing are shown graphically. No attempt is made to draw an average

Bill Gavin

CHART X

– right grip
– left grip

DIURNAL GRIP SCORES OF SUBJECT W.G.


DIURNAL RIGHT GRIP SCORES OF SUBJECT H.P.
8:00 9:00 9:30 10:00 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30 6:30 7:30 8:30 9:30 10:30
8:30 9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30 6:30 7:30 8:30 9:30 10:30 11:30
9:30 11:30 1:30 3:30 5:30 7:30 8:30 11:30
1
2
3
4
5
6
24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
160 155 150 145 140 135 130 125 120
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18


DIURNAL LEFT GRIP SCORES OF SUBJECT H.P.
8:00 9:00 9:30 10:00 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30 6:30 7:30 8:30 9:30
8:30 9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30 6:30 7:30 8:30 9:30 10:30 11:30
9:30 11:30 1:30 3:30 5:30 7:30 8:30 11:30
1
2
3
4
5
6
24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 3 2 1
130 125 120 115 110 105 100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

curve, because testing hours varied, making the frequency of cases so few that averages would not be very significant. First testing periods, which came shortly after arising, varied between 8:00 and 11:30 A. M. Lunch was eaten at 12:00, and dinner at 5:15. Bed time ranged between 10:30 and 11:30. On the sixth day the last test, taken at 7:30, brought a very low score due to a sore hand, causing the subject to discontinue testing. In general the first test in the morning revealed the low point of the day. An exception was the 7:30 P.M. test on the sixth day, just mentioned, when a sore hand affected the grip. Another exception was the second day when the subject took a nap after lunch, after which his grip dropped two points below his 8:30 score. Morning peaks were generally reached two hours after arising, and afternoon peaks from an hour and a half to two hours after lunch. This subject was a comparatively late riser in the morning, and had a relatively high grip score at the time of the last testing at night. On page 80 is a chart on which his left-grip strength scores for the six days are shown graphically. In general the daily patterns are quite similar to those of the right grip. On the sixth day the right grip increased ten points between 9:30 and 11:30, while the left grip decreased ten points; and on the first day, peaks were reached with the right grip at 2:30 and at 6:30, while the left grip peak was reached at 10:30 A.M. We could find no plausible explanations for these exceptions.

Summary

These studies contribute little to, but rather add evidence to substantiate some of the findings reported in Further Adventures with Grip Strength Tests mentioned in Chapter I. Certainly evidence is very strong that one's physical powers are at low ebb the first hour in the morning.

Normally, powers seem to gather until they reach a high point late in the morning, usually around 11:00 o'clock. This may be the peak of the day as it was with W.G., who because of his heavy work load, forty-five hours per week, with four hours of it coming each morning, was not able during the afternoon or evening, to reach his morning peak. Three o'clock in the afternoon seems to be another common peak period, which with many people would be the high point of the day. With very active students, another peak, which does not reach the high point of either morning or afternoon, comes early in the evening, and as the hour for retiring approaches, grip strength then steadily declines.

Educational psychologists believe that mental and physical efficiency varies during the course of a day, and many of their findings support the conclusions drawn from grip strength studies. Gardner Murphy, in reporting studies with industrial workers writes

"The output of work of both hand and brain workers draws 'steaming up' during the morning, a high level about 11, a depression before lunch, another spurt between 2 and 3 o'clock, and again a big decline"[1]

Arthur I.Gates studied diurnal changes in efficiency with grade school children as subjects. He writes

".....efficiency is lowest in the first and highest in the last morning period. A slight drop follows the lunch period with a subsequent rise between two and three o'clock. Other investigations have shown a very similar distribution of efficiency for gross bodily functions, such as shoveling and lifting."[2]

[1]Gardner Murphy, GENERAL PSYCHOLOGY, New York and London: Harper & Brothers Publishers, 1933, p. 518.

[2]Arthur I. Gates, PSYCHOLOGY FOR STUDENTS OF EDUCATION, New York: The MacMillan Company, 1930, pp. 470 and 471.

CHAPTER VI

A STUDY OF CAUSES WHICH INFLUENCE CHANGES IN STUDENTS OTHER THAN VARSITY ATHLETES

A Dormitory Group

The dormitory group of thirty-four men was a heterogenious group, with varying programs in regard to curricular and extra-curricular programs, activity, and rest.

Each evening for ten weeks this group was checked for right and left grip strength; and deviations from normal averages were investigated for causes.

Most common causes of slumps in grip strength were caused by colds, lack of sleep, and an over-tired condition, due to strenuous exercise over worry, over examination. Lack of sleep and an over-tired condition usually would go to-gether, but the separate classification implies that scores in the third group were affected by causes other than lack of sleep.

Though it is quite possible that every case of a cold, loss of sleep, or overtired condition was not reported, during seventeen colds right-grip scores averaged 7.36 points, and left-grip scores 7.11 points below the normal averages. On fourteen days, when an over-tired condition was reported, right-grip scores averaged 9.04 points and left grip scores 4.35 points below a normal average. On eighteen days, which followed an unusual loss of sleep, right-grip scores 7.17 points below the normal average. If the individuals had undergone a period of strenuous exercise on the days of colds, or following a loss of sleep, judging from the results of the wrestling group, there would have been an even geater loss of grip strength.

CHART XIII

GRAPH SHOWING NUMBER OF POINTS BELOW NORMAL

AVERAGE OF DORMITORY MEN ON ABNORMAL DAYS

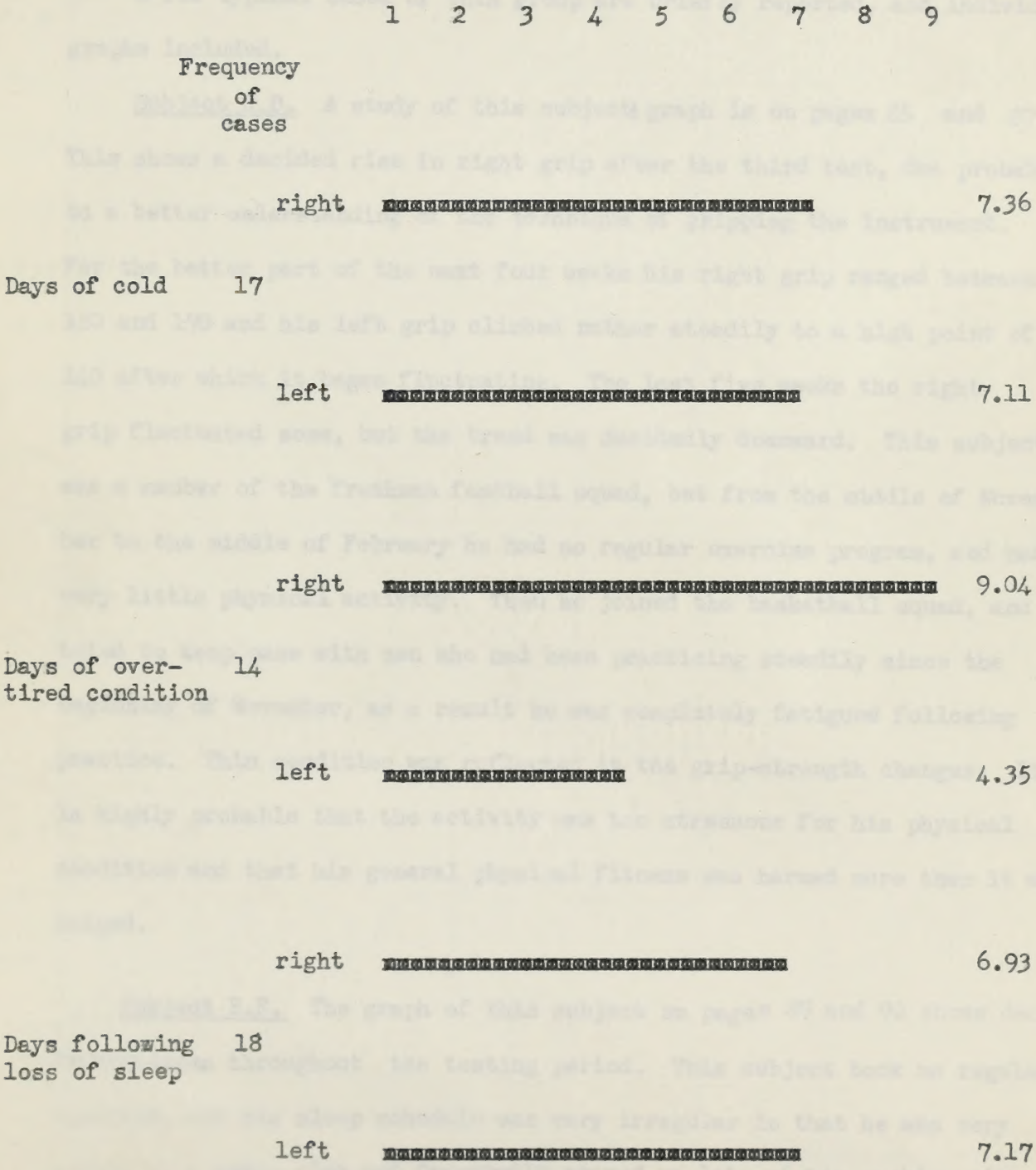


Chart XIII on page 84 shows average group deviations below normal, caused by the factors that are discussed above.

A few typical cases of this group are briefly reported, and individual graphs included.

Subject C.D. A study of this subject's graph is on pages 86 and 87. This shows a decided rise in right grip after the third test, due probably to a better understanding of the technique of gripping the instrument. For the better part of the next four weeks his right grip ranged between 150 and 170 and his left grip climbed rather steadily to a high point of 140 after which it began fluctuating. The last five weeks the right grip fluctuated some, but the trend was decidedly downward. This subject was a member of the freshman football squad, but from the middle of November to the middle of February he had no regular exercise program, and had very little physical activity. Then he joined the basketball squad, and tried to keep pace with men who had been practicing steadily since the beginning of November, as a result he was completely fatigued following practice. This condition was reflected in the grip-strength changes. It is highly probable that the activity was too strenuous for his physical condition and that his general physical fitness was harmed more than it was helped.

Subject E.F. The graph of this subject on pages 89 and 90 shows decided fluctuations throughout the testing period. This subject took no regular exercise, and his sleep schedule was very irregular in that he was very active in a radio club and frequently stayed up late nights working with radio experiments. The first few days of the test he was just recuperating from a succession of cold.

Clay Davis

CHART XIV

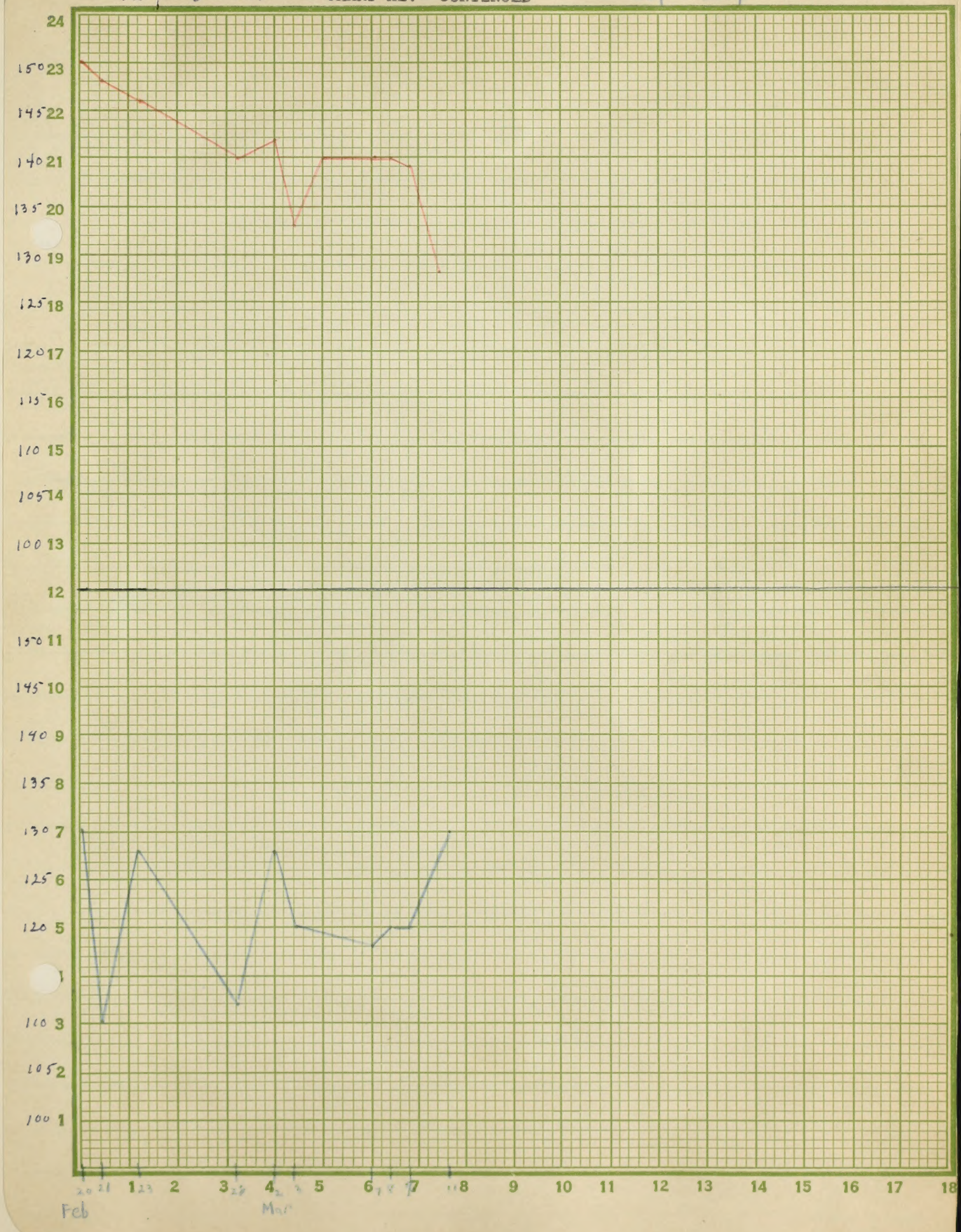
— Right Grip
— Left Grip

GRIP STRENGTH GRAPH OF SUBJECT C.D.

Clay Davis

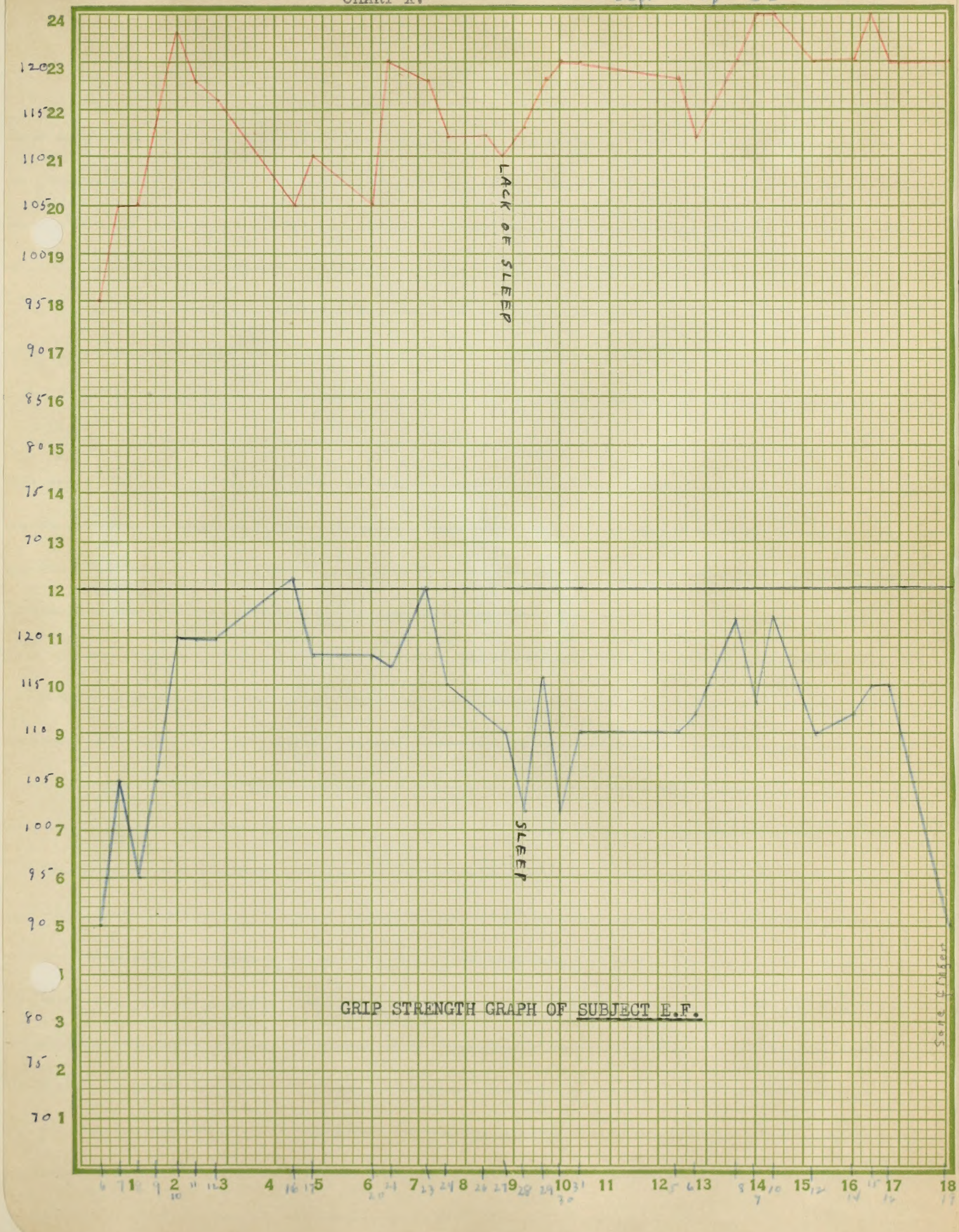
CHART XIV--CONTINUED

– Right Grip
– Left Grip



Edward Frizen CHART XV

— Right Grip
— Left Grip



GRIP STRENGTH GRAPH OF SUBJECT E.F.

Edward Frizen

CHART XV--CONTINUED

– Right Grip
– Left Grip

Subject E. Fa. A study of this subject's graph on pages 91 and 92 shows that noticeable deviations from normal averages of 129.63 right and 118.11 left took place between January 15 and January 31. From a right-grip score of 130 on January 15 the line drops quite steadily to a low point of 111 on January 25. From that point the line goes steadily back up to 130 on January 31. During this two-week period the left grip fluctuated pretty much between 105 and 120 with eight scores well below normal and five scores at or above normal. On January 23 the graph shows a jump to 140 in left grip though the right grip was only 120. Since at no other time during the ten weeks did the subject approach such a high left-grip score it is quite possible that this was an error in reading or recording the score.

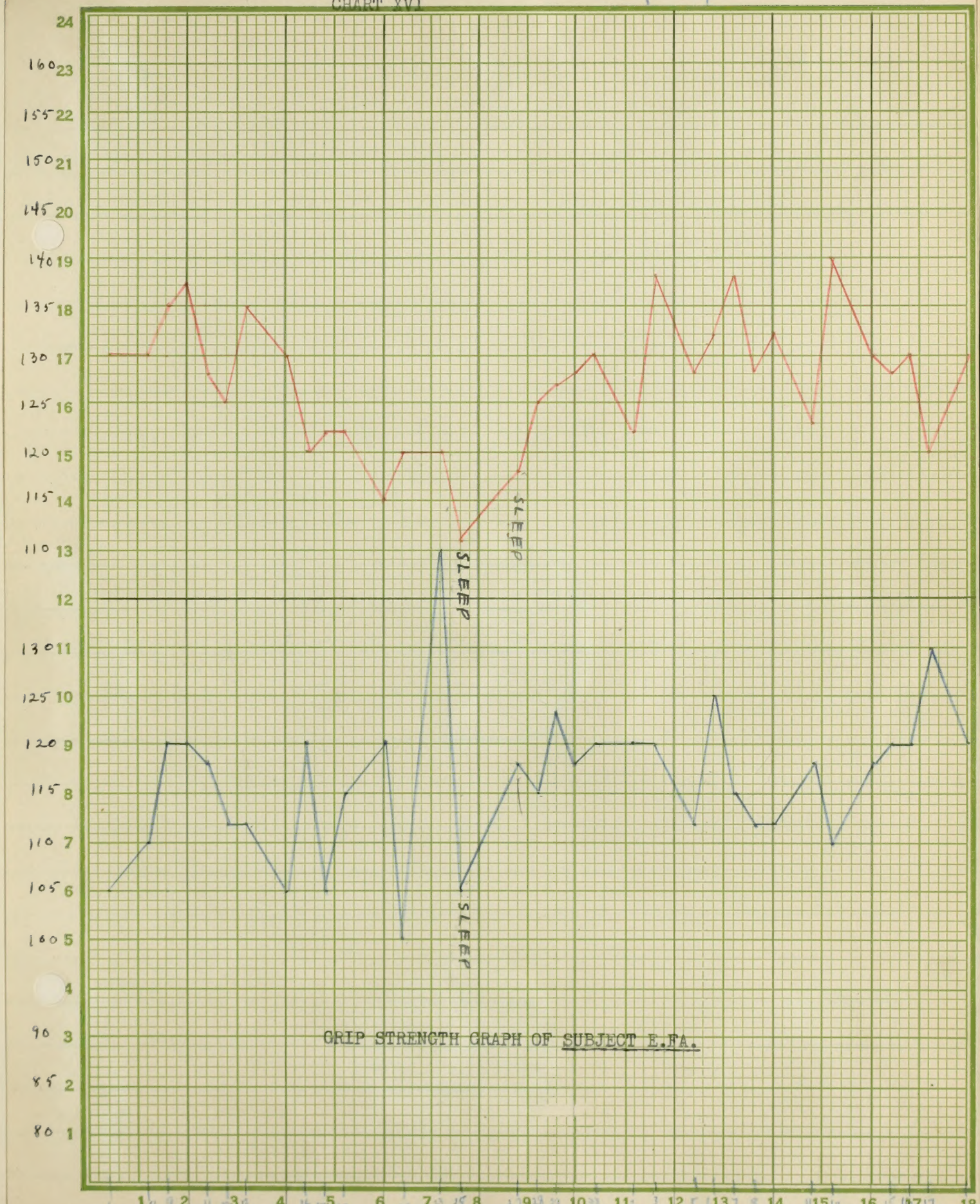
The first part of this two-week period when the subject's right grip was dropping steadily, marked the period leading up to and including semester examinations. During the period E. Fa. worried over examinations and stayed up late nights studying. Evidently the subject's fitness was low at this time and was marked by a steady decline in right grip, and a fluctuation in left grip, which was considerably below average the majority of the time.

Subject C. S. The graph of this subject is on pages 93 and 94. This subject was similar in temperament to E.Fa. and through worry and loss of sleep suffered a loss in both right and left grip strength during the semester examination period. From an average of 125.74, his right grip hung around 120 during the period, reached a low point of 110. His left-grip average was 123.06 and during the examination period ranged between 120 and 110, with four scores reaching the lower level.

Edwin Farmer

CHART XVI

— Right Grip
– Left Grip

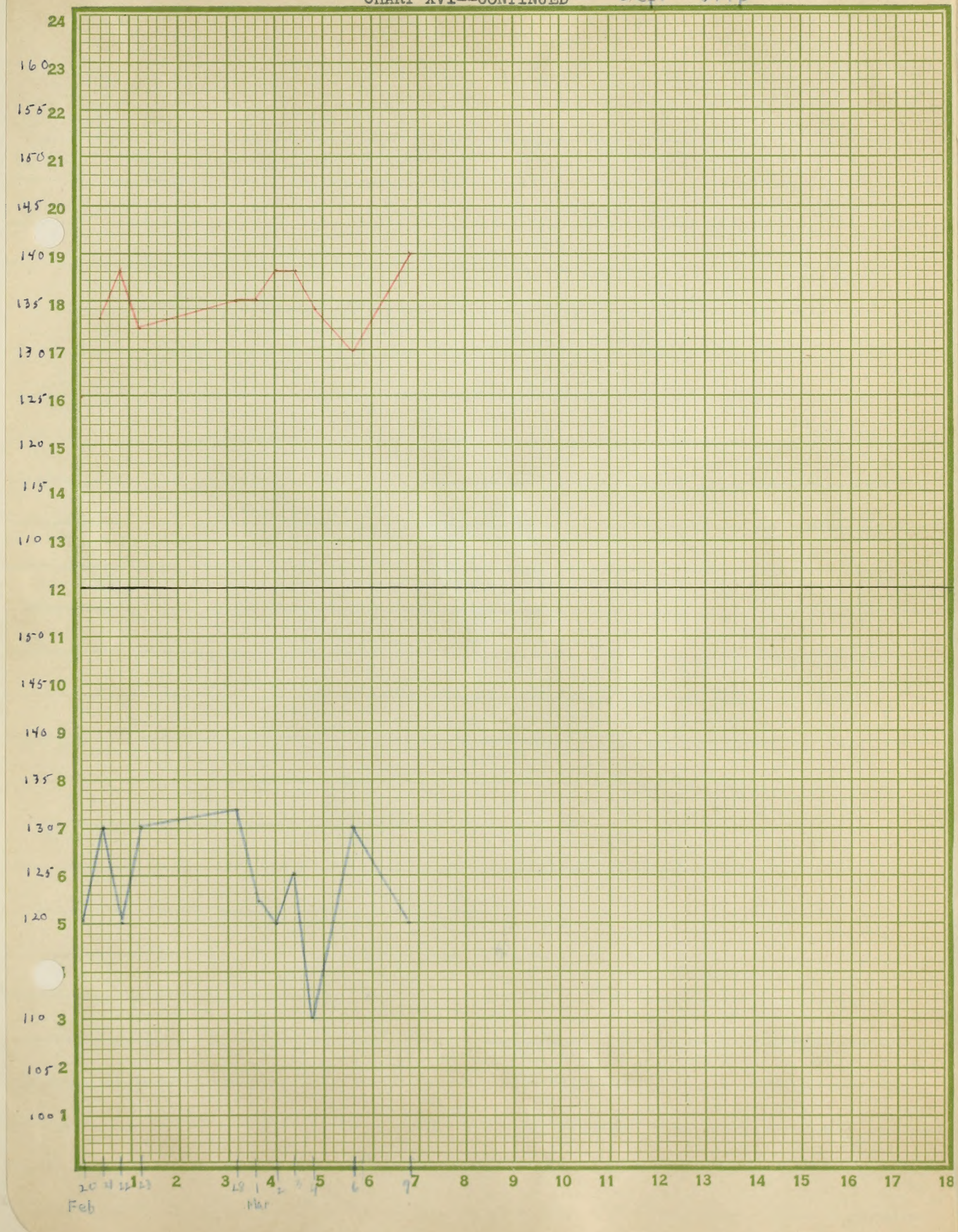


GRIP STRENGTH GRAPH OF SUBJECT E.FA.

Edwin Farmer

92

CHART XVI--CONTINUED – Right Grip
Left Grip

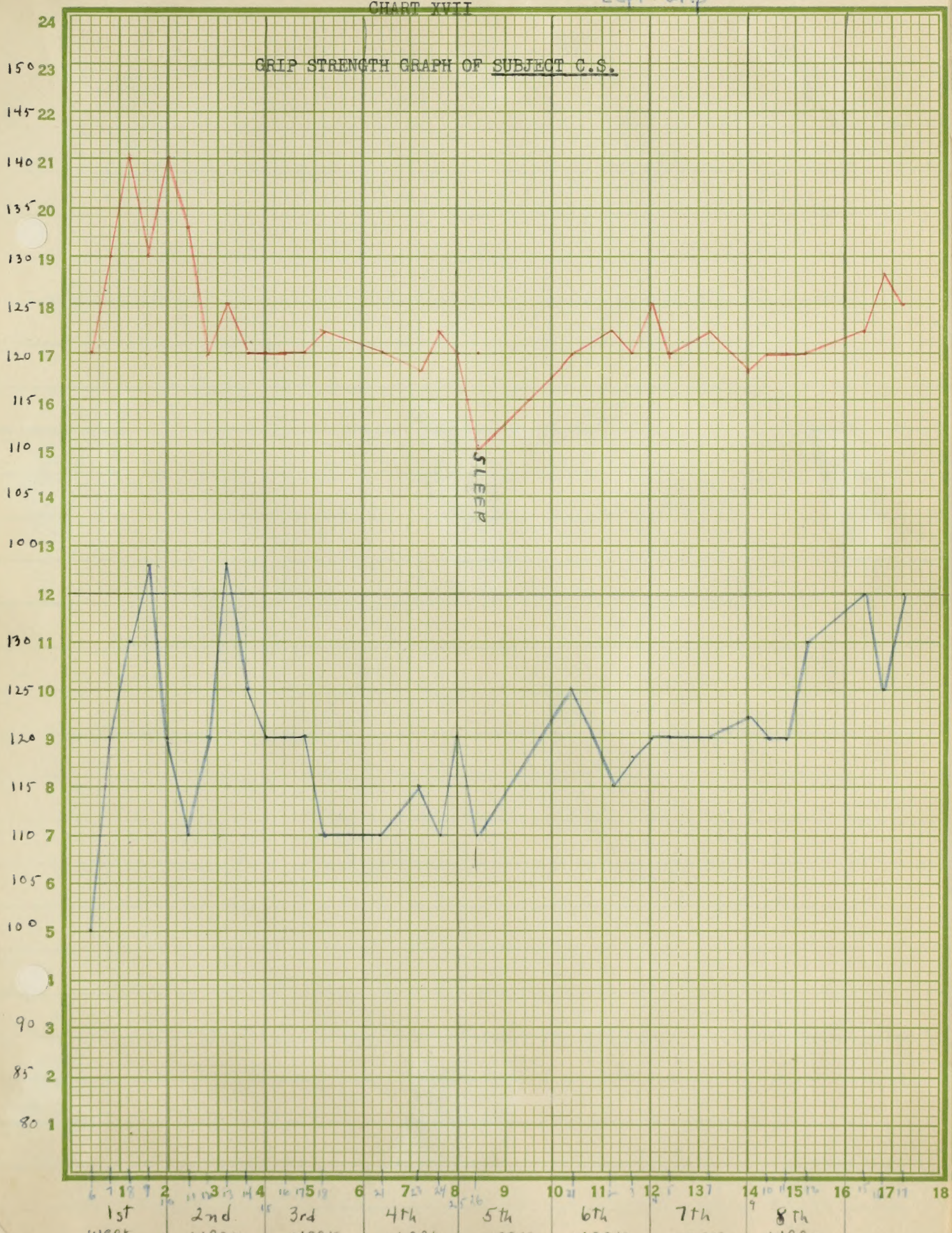


Clarence Schnicke

– Right Grip
– Left Grip

CHART XVII

GRIP STRENGTH GRAPH OF SUBJECT C.S.



Clarence Schnicke 94

— Right Grip
— Left Grip

CHART XVII - CONTINUED

Subject D.N. His graph is on pages 96 and 97. This subject had a right grip normal average of 164.87. On days of reported colds he had two right grip scores of 150, one of 142, one of 157, one of 160, and one of 163. His left grip normal average was 137.66. On the days of reported colds he scored 120 twice, 130 three times, and 140 once. Colds noticeably affected his grip strength.

Rooming House: Group of Ten Men

This group was tested from November 18 through December 15, and from January 4 through the month of February, approximately twelve weeks. The tester in this case was one of the group, and he was able to keep a careful check on conditions and factors which might cause physiological disturbances. Daily grip-strength scores were taken and individual graphs charted.

At the end of the period scores for each individual were separated into four columns: those recorded on days when the subject was apparently normal in health, those taken on days when there were evident symptoms of a cold, those days which followed nights of less than normal sleep, and days which came within the semester-examination period. Table XVII gives average scores of each individual for each of these different classifications. Table XVIII gives the number of points in which average scores of the latter three classifications deviate above or below the average scores of normal days.

Delburt Nelson 96

CHART XVIII

GRIP STRENGTH GRAPH OF SUBJECT D.N.

Delburt Nelson

CHART XVIII--CONTINUED

— Right Grip
— Left Grip

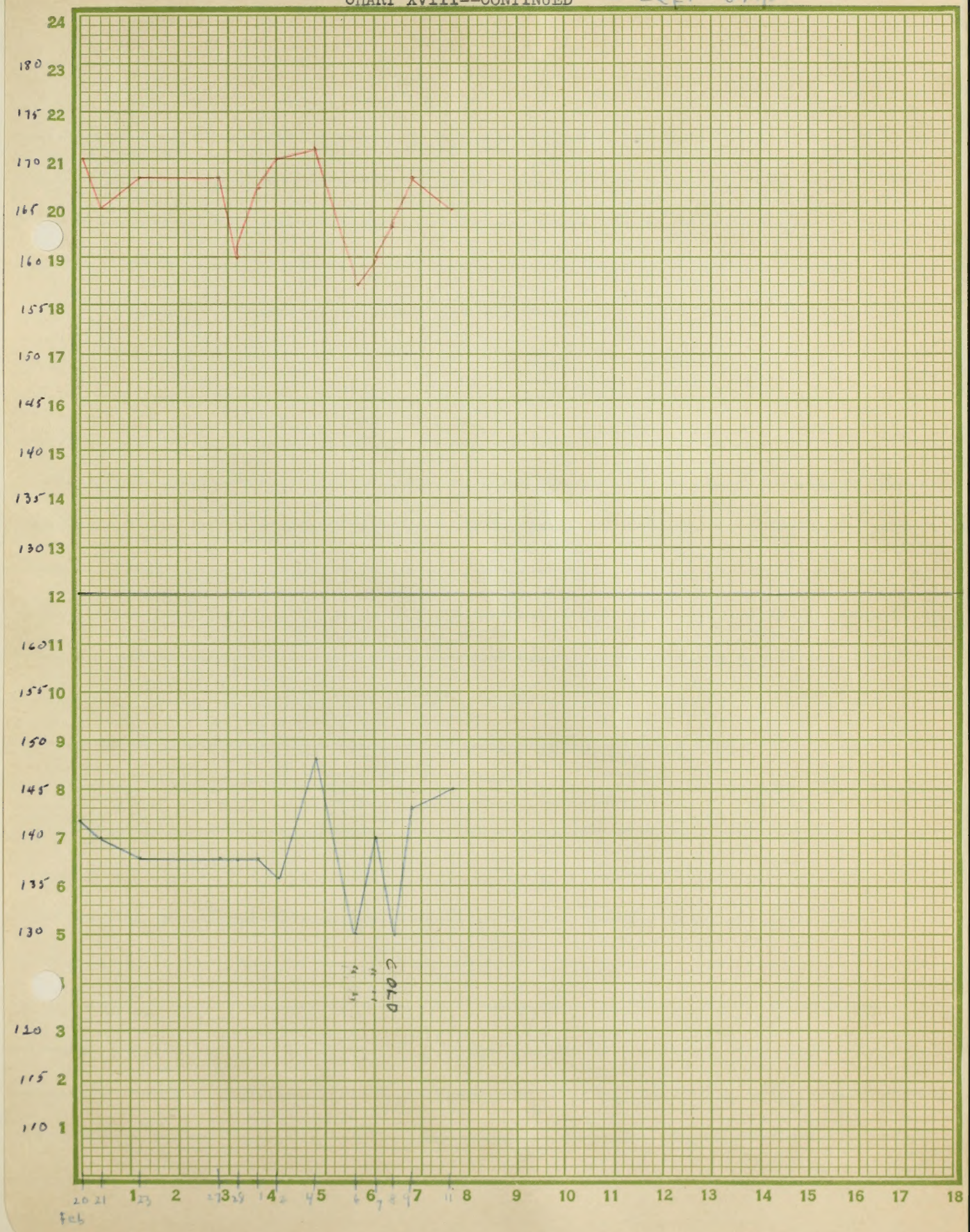


TABLE XVII

Chart of Rooming House Group

Subjects		Normal	Cold	Sleep	Exams
A	R	109.18	100.33	104.25	103.6
	L	108.36	97.45	104	104
B	R	99.23	94.86	96.5	96.17
	L	95.21	91	86.5	92.86
C	R	177.55	171.73		175.17
	L	157.6	146.89		154.67
D	R	124.52	121.14	116.73	120.46
	L	Record on left inadequate for survey. Injured hand-fault.			
E	R	126.62	119	125.11	128.83
	L	113.08	106.5	109.11	108.83
F	R	123.35	123.5	120.5	124.71
	L	129.32	122	126.5	128.14
G	R	125.18	130.15	128	126.8
	L	127.5	128.67	127.85	123.8
H	R	106.78	104.72	100.78	103.51
	L	121.53	119.72	119.54	120.43
I	R	145.21		138.6	142.6
	L	129.44		121.83	128
J	R	123.69	123.11		122.63
	L	113.18	114		112.86

TABLE XVIII

Deviations of Rooming House Group on Abnormal Days

Subjects		Normal	Cold	Sleep	Exams
A	R	109.18	- 8.85	- 4.93	- 5.58
	L	108.36	- 10.91	- 4.36	- 4.36
B	R	99.23	- 4.37	- 2.73	- 3.06
	L	95.21	-4.21	- 8.71	- 2.35
C	R	177.55	- 5.82		- 2.38
	L	157.6	- 10.71		- 2.93
D	R	124.52	- 3.38	- 7.79	- 4.06
	L	Record on left inadequate for survey due to injury.			
E	R	126.62	- 7.62	- 1.51	+ 2.21
	L	113.08	- 6.58	- 3.97	- 4.25
F	R	123.35	+ .15	- 2.85	+ 1.36
	L	129.32	- 7.32	- 2.82	- 1.18
G	R	125.18	+ 4.97	+ 2.82	+ .62
	L	127.5	+ 1.17	+ .35	- 3.7
H	R	106.78	- 2.06	- 6.00	- 3.27
	L	121.53	- 1.81	- 1.99	- 1.10
I	R	145.21		- 6.61	- 2.61
	L	129.44		- 7.61	- 1.44
J	R	123.69	- .58		- 1.06
	L	113.18	+ .82		- .32

Looking at the deviations on days of colds, it can be seen that seven subjects were below normal strength in both hands; one, a natural left-hander, was well down in left grip, but very slightly above normal in right grip; one, a natural right-hander, was slightly down in right grip and slightly up in left grip; while one was up in both hands. With respect to the latter, the subject was also above normal on days that he reported a lack of sleep, and there will be a brief case study report of this subject later in this chapter.

In the column of averages on days following a loss of a normal amount of with the single exception of Case G, already mentioned, noticeable losses in both right and left grip are evident.

Scores in the fourth column indicate that the strain of examinations has a weakening affect upon grip. Seven subjects suffered a loss in both right and left grip strength; two, both natural right-handers, were above normal in right grip but had a sufficient loss in left grip to bring the average grip below par; while one, a natural left-hander, was below normal in left grip but his increase in right grip was high enough to slightly more than compensate for his left grip loss.

This group contributed strong evidence to the general rule that colds; fatigue, due to lack of sleep; and fatigue, due to strain and worry, are reflected in loss of grip strength. Exceptions to the general rule were too few and too slight to destroy the effectiveness of the evidence.

A few case studies of individuals in this group are significant.

Case G--This subject, mentioned previously, was the only case in the group whose grip-strength was noticeable higher on days of colds or days following lack of normal amount of sleep. Such a case is, of course difficult to account for, but the answer might be at least partly due to personality. This subject carries no more than an average student schedule of activity and is apparently in good health, but talks considerably about not feeling well. As a member of one of the athletic teams he irritated some of his team mates by frequent complaints of his poor condition before a contest. It is quite possible that on the days he reported himself to be ill or behind on sleep that it was a mental condition, and that he was in reality physically sound.

Case E--This subject worked regularly from 5:30 to 7:00 A.M., carried a normal academic schedule, and a heavy program of extra-curricular activities. He was a regular participant in intra-mural athletics. His average sleep schedule was four-and-one-half to six hours a night, and on some nights was under that. One might expect him to lose more than 1.51 points on days of abnormal loss of sleep; but since his sleep schedule has been relatively low for several years, he has evidently become accustomed to getting along on less sleep than the average person gets.

Case H (Graph on pages 106-07)--Though this subject followed the general rules of changes in grip strength, special mention is made of his case because of the comparative steadiness of his grip strength. This is illustrated in his individual graph, which is included in this report along with the graphs for the other three special cases. This subject carried a normal academic load, did no outside work, participated in few extra-curricular

George Kollmar — right — left 102

CHART XIX

GRIP STRENGTH GRAPH OF SUBJECT G

George Kollmar 103

CHART XIX CONTINUED

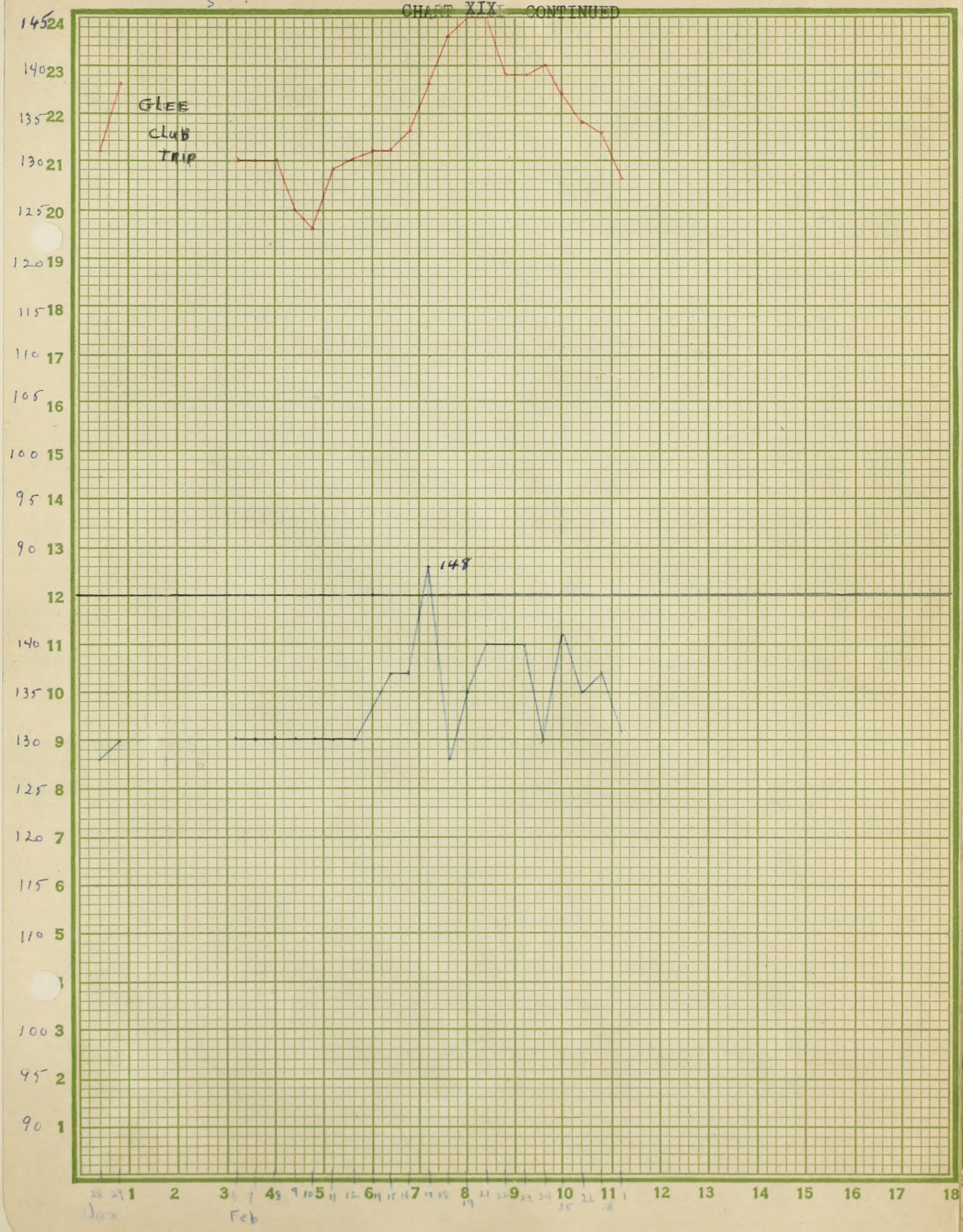


CHART XX

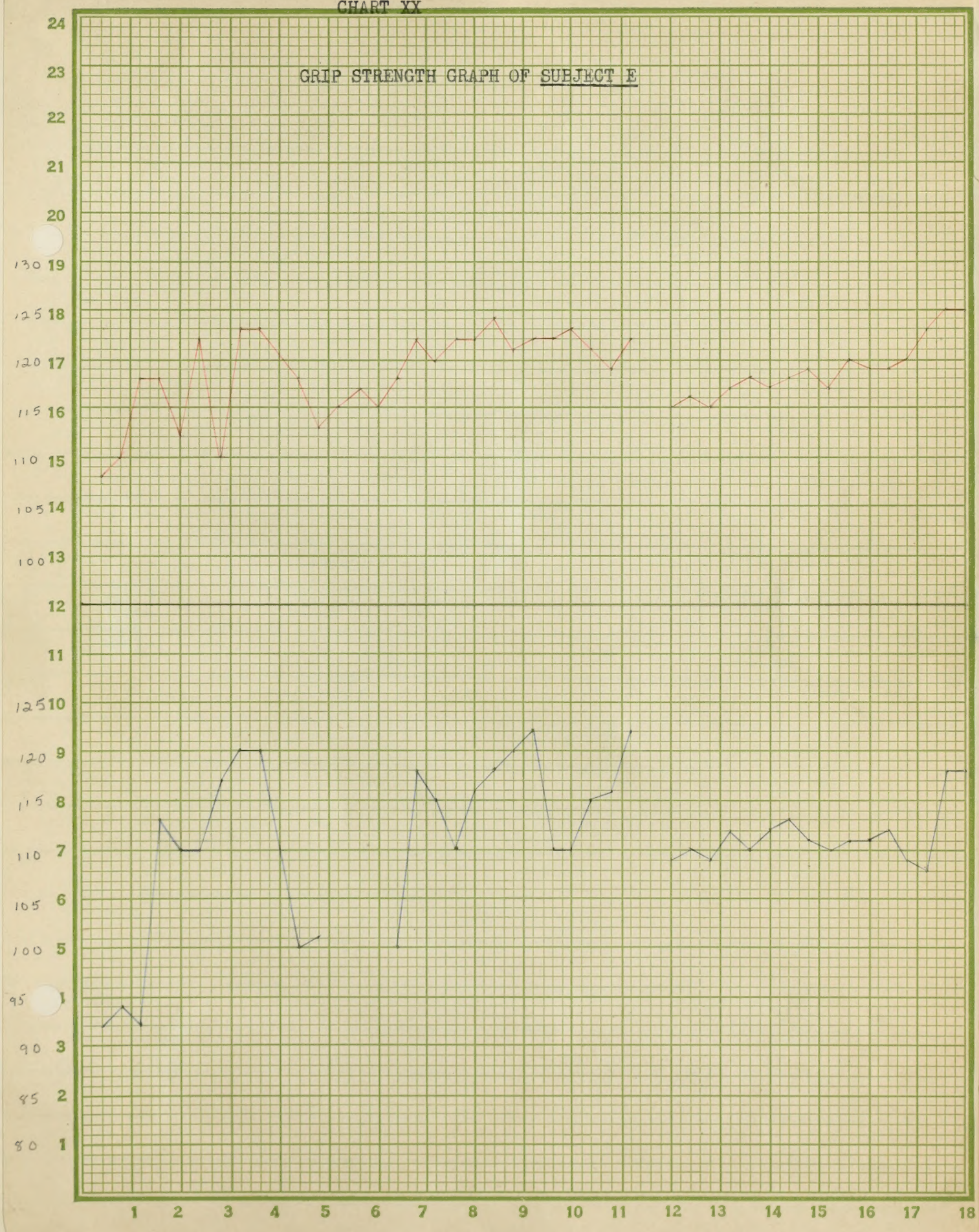
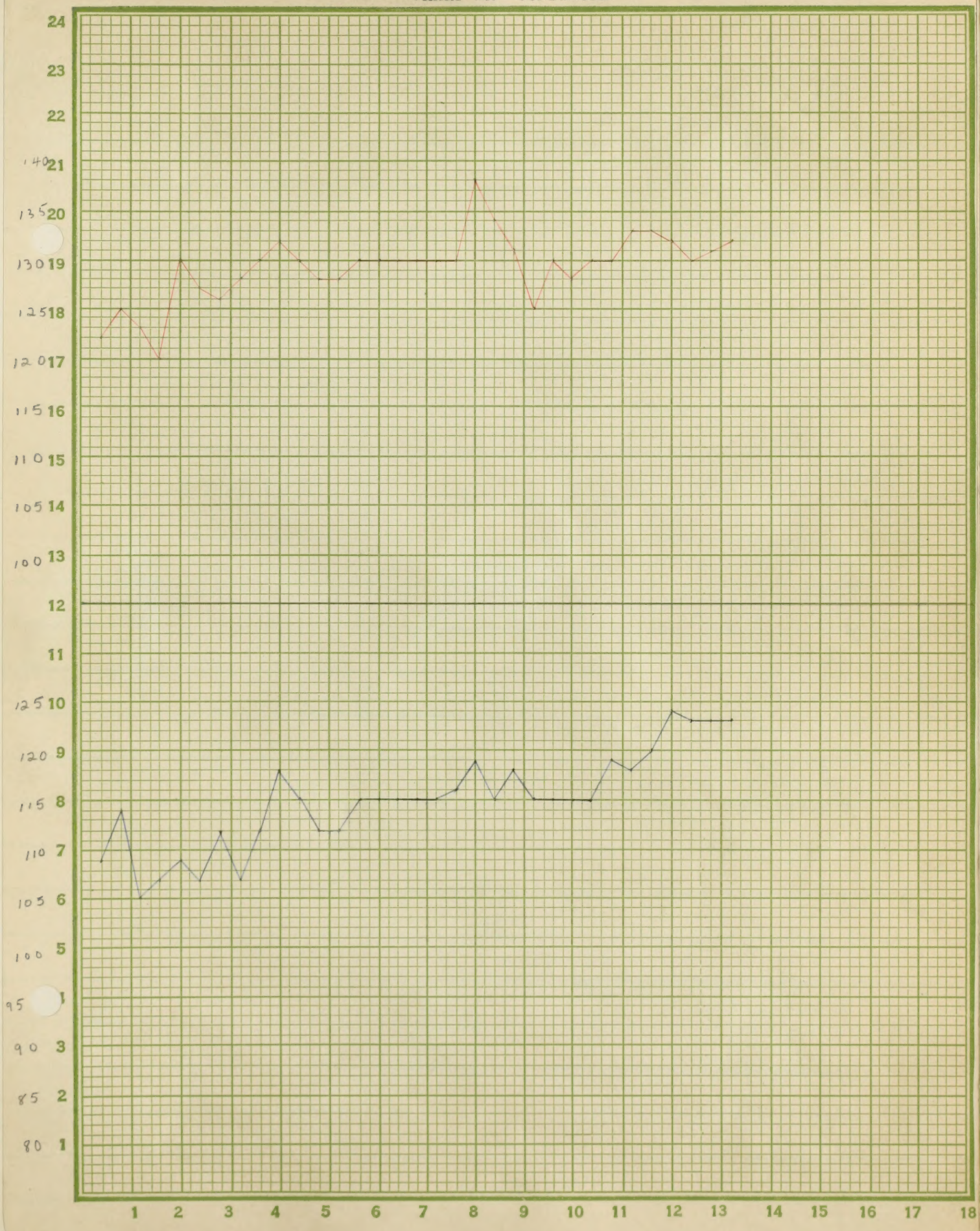
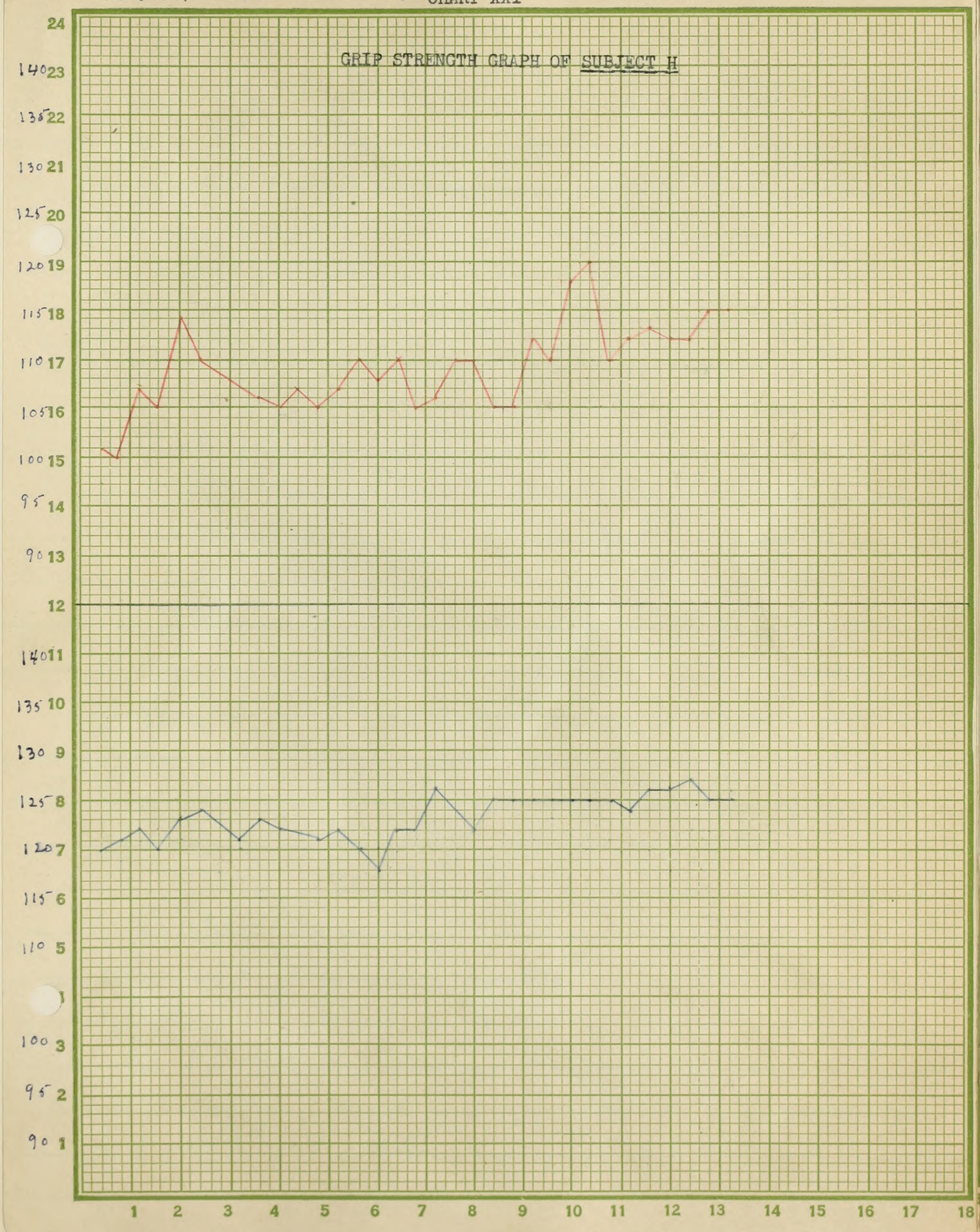

GRIP STRENGTH GRAPH OF SUBJECT E
24
23
22
21
20
130 19
125 18
120 17
115 16
110 15
105 14
100 13
12
11
125 10
120 9
115 8
110 7
105 6
100 5
95 4
90 3
85 2
80 1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CHART XX--CONTINUED

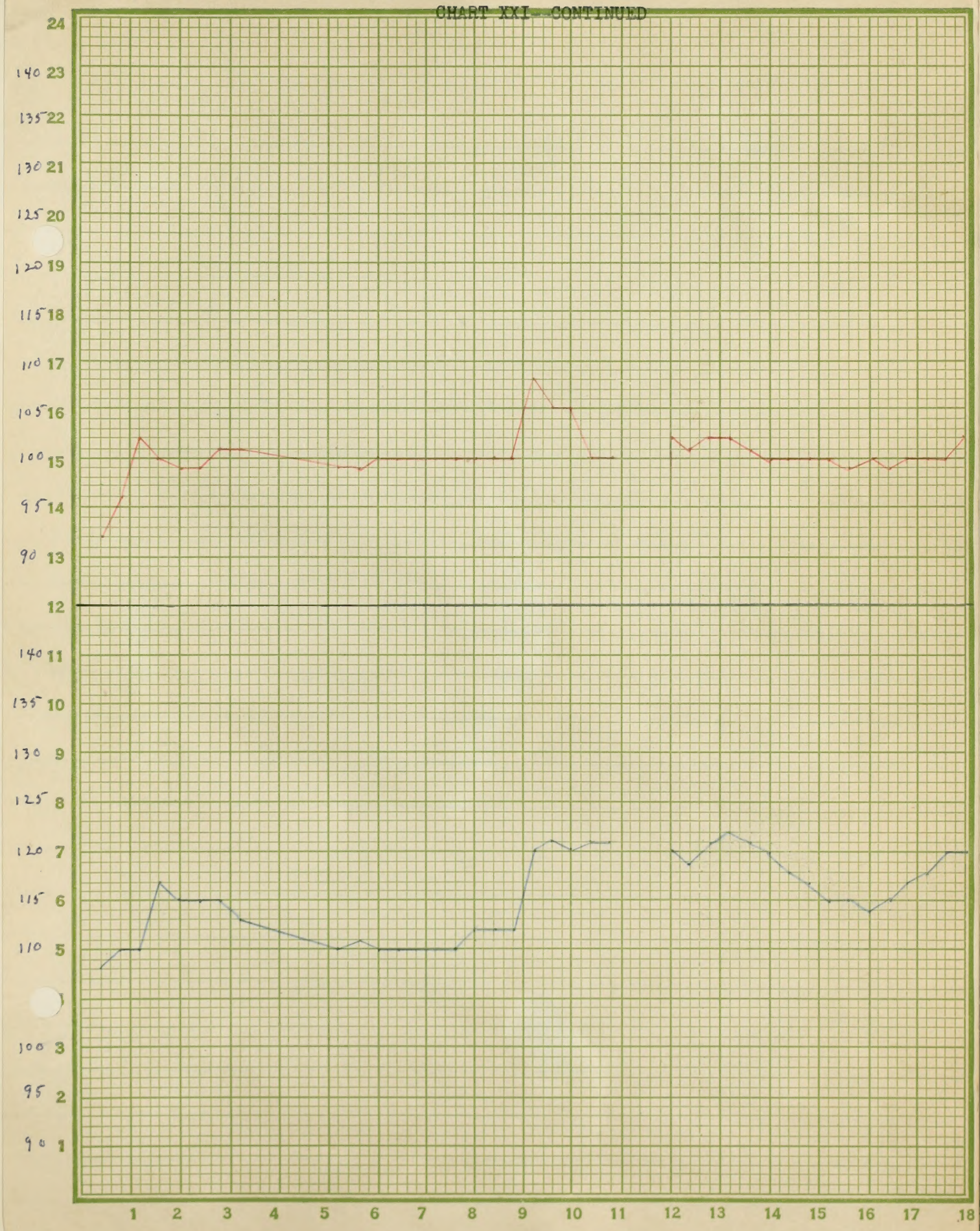


John Frazer MacLean CHART XXI



John Frazer MacLean

CHART XXI- CONTINUED



activities, and carried just the regular required Physical Education program for his exercise. He slept seven hours a night regularly and followed a regular daily routine. Except for a cold early in January he had no sickness. As will be noted on the graph, his record shows a decline during the period of the cold and a slight decline during the examination period; otherwise his grip-strength scores remained remarkably steady.

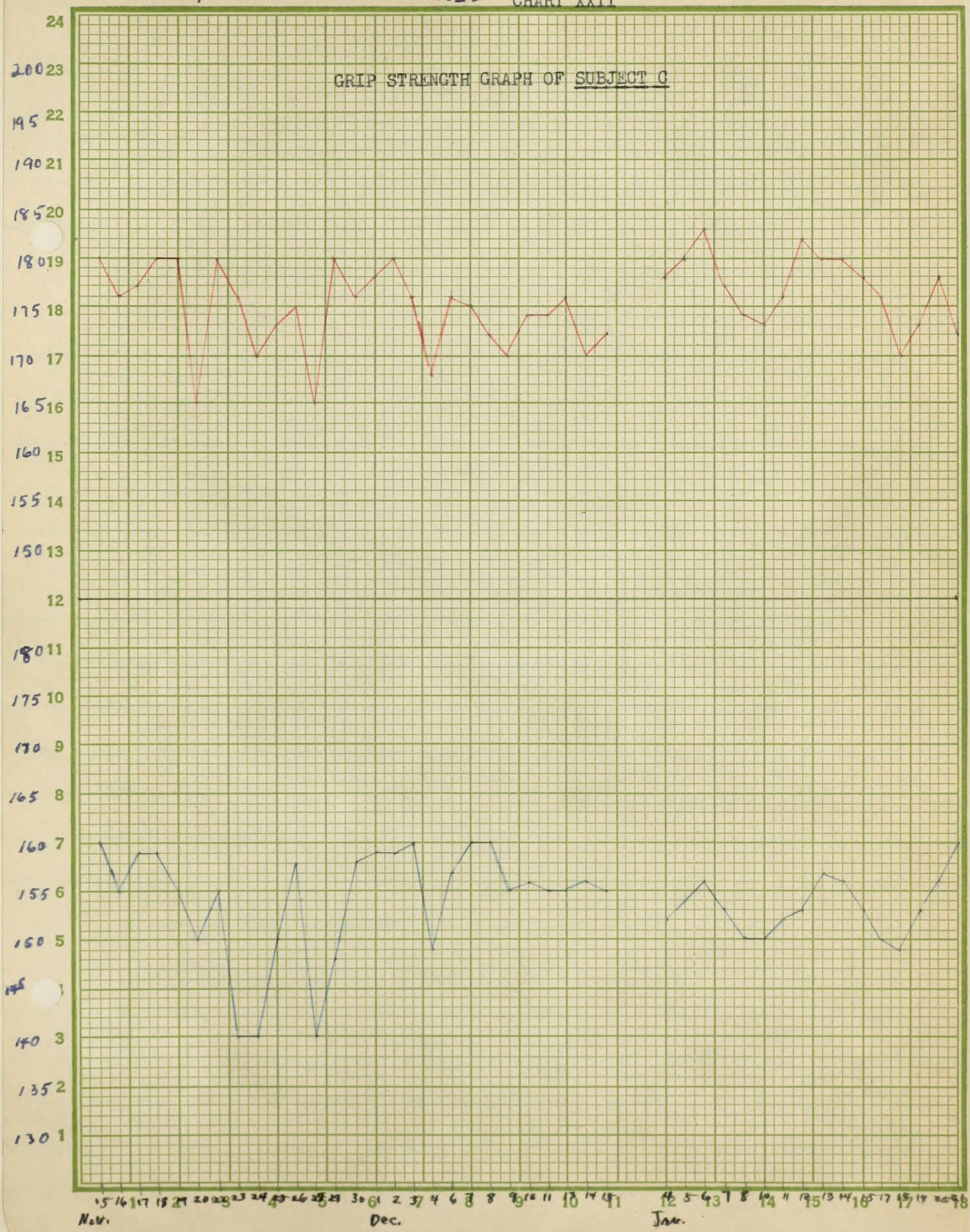
Case C (Graph on pages 109-10) This subject joined the varsity basketball squad after the Christmas holidays. It will be noted that his grip-strength remained steadier after he took up basketball, though there are four noticeable dips in this period caused by colds. During the period that he was not exercising regularly his grip-strength fluctuated more, doubtless because his body was not conditioned to throw off the effects of factors which tend to lower his physical fitness.

Part-Time Cafeteria Workers

This was a group of eight men who were working their way through school. Specifically, their work was peeling vegtables, which was not heavy work but did take time. The work schedule of this group ranged from twenty-five to fifty hours a week for each man, with an average of thirty-eight-and-one-half hours a week. Each of these men carried a normal load of academic work. These men did not have much time for extra-curricular college activities; though one did play varsity basketball, one sang in the glee club, and one worked out with the varsity wrestling squad for a part of the period. Two of the men took physical education class work, and two others followed a daily program of calisthenics. One of the latter was stimulated to do this through interest aroused by the grip-strength testing. Two of the men had no exercise program at all.

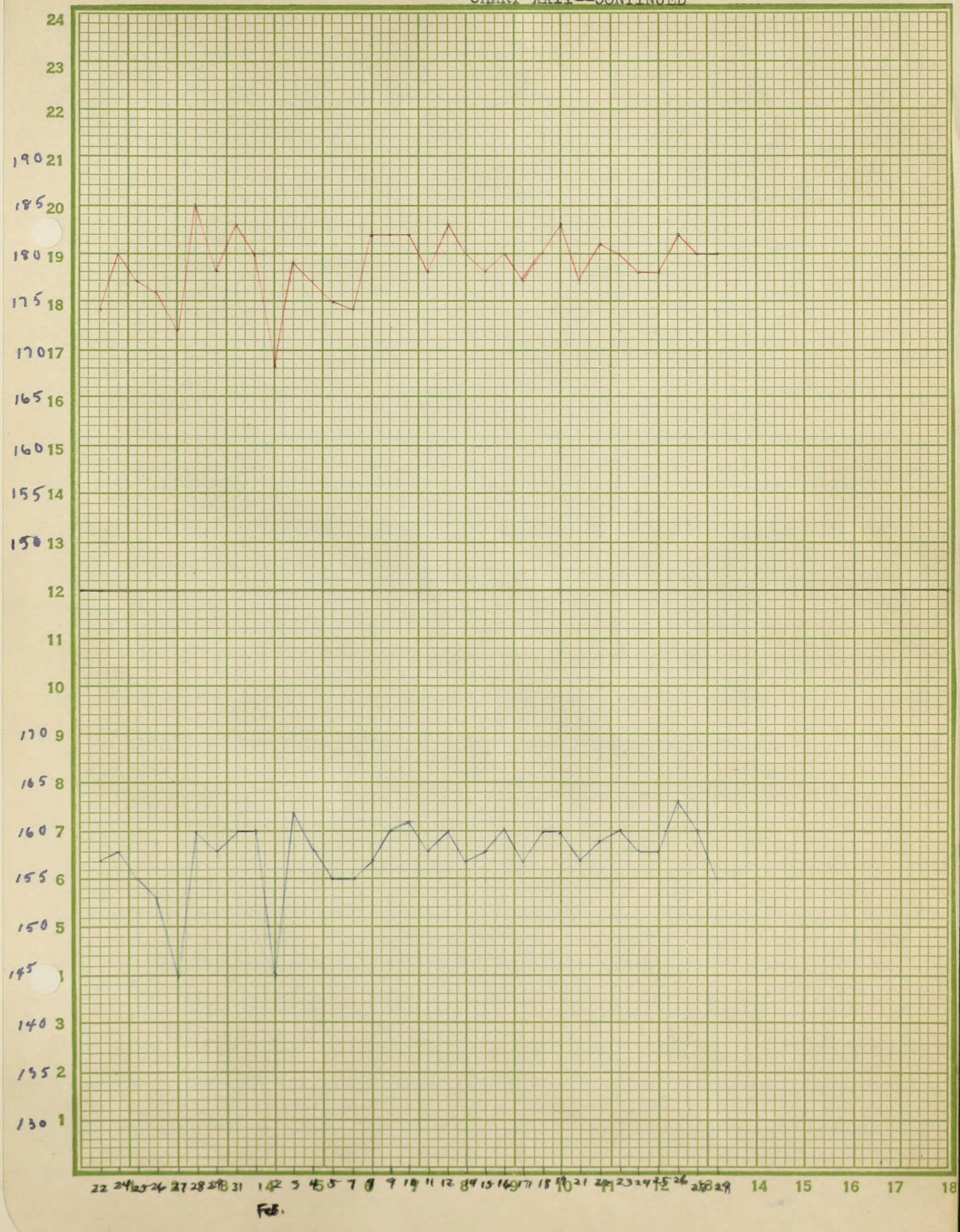
Rudolph Schlegel — right — left

CHART XXII



Rudolph Schlegel

CHART XXII--CONTINUED



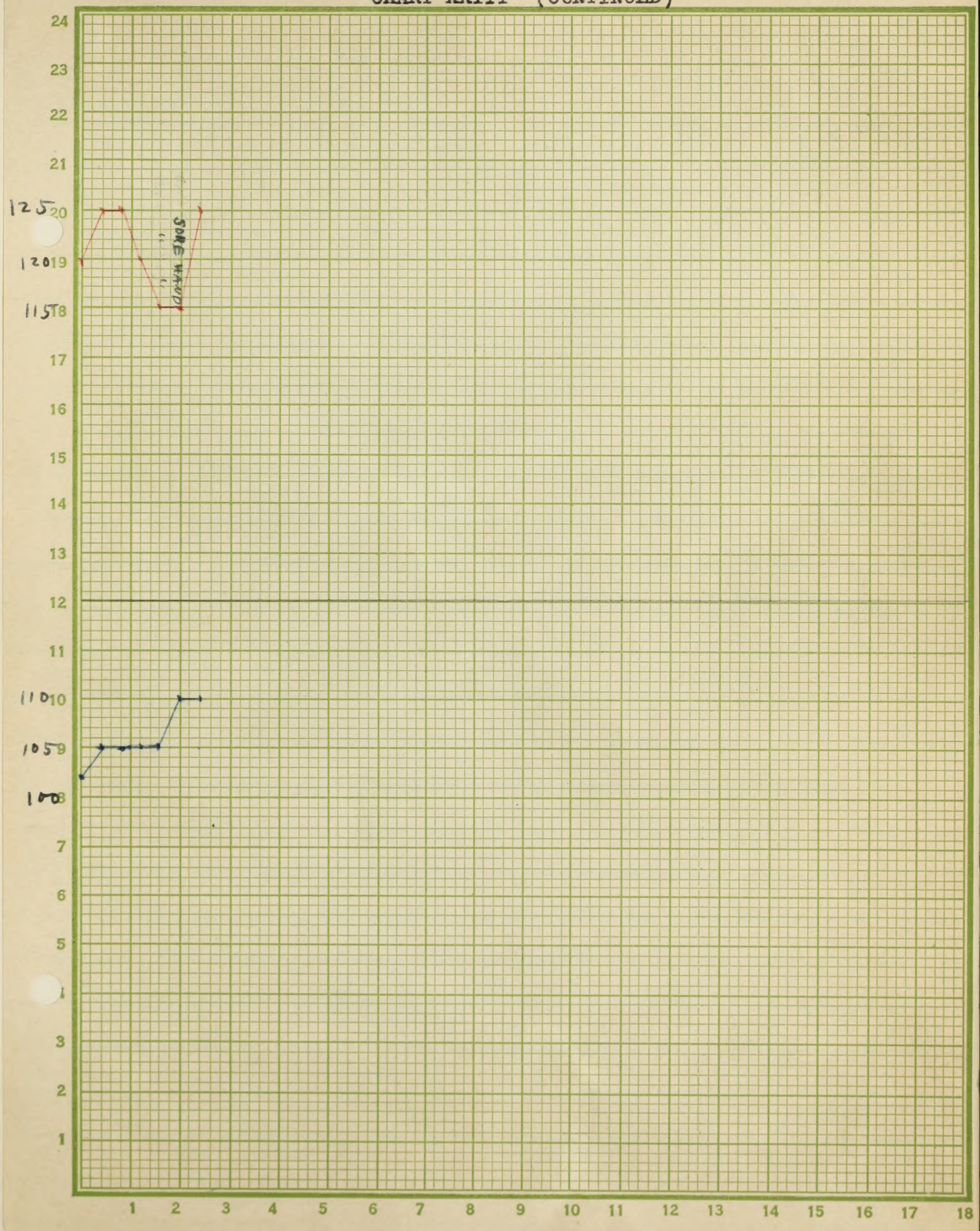
In contrast with many of the men in the dormitory groups whose programs of daily activity varied widely from day to day, the men in this group, of necessity, were quite regular in their daily programs. A study of the graphs of this group would indicate that the grip strength scores of these men were less affected by loss of sleep and minor illness than were the grip strength scores of men in the dormitory groups. A superficial study might thus lead one to believe that the findings from a study of this group would refute conclusions drawn from studies of the other groups. However, it seems reasonable to conclude that these men, who were following a more regular program of sleep and activity than most students, were better conditioned to throw off the affects of slight physiological disturbances. Had it been possible to control this group sufficiently to have had these men exercise vigorously on days of colds or days following abnormal loss of sleep it is highly probable that they would have lost considerably in grip strength. This was true of the varsity wrestlers, who frequently did not register a noticeable loss before practice on abnormal days, but did register a loss much greater than the average following practice. All testing was done at 7:30 each morning.

Chart XXIII on pages 112-3 is a graph for D.K., who was tested from February 4 to March 7. He was a varsity basketball man who practiced basketball about two hours daily except on days of games, which averaged about twice a week. He worked twenty-eight hours a week. His grip-strength scores were very steady, remaining at, or close to, 100 for the left and 115 for the right, quite consistently. At several points, loss of sleep was reflected in loss of grip strength, right grip being the more sensitive. The last week and a

CHART XXIII


GRIP STRENGTH GRAPH OF SUBJECT D.K.
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
3
2
1
125
120
115
110
100
95
90
85
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CHART XXIII (CONTINUED)



half of the testing period was after the close of the basketball season, and it will be noticed that, except for three days when the subject had a sore right hand, scores were consistently higher than they had been during the season. This would indicate that the rest period following a strenuous season of competitive sport was beneficial to the fitness of the subject.

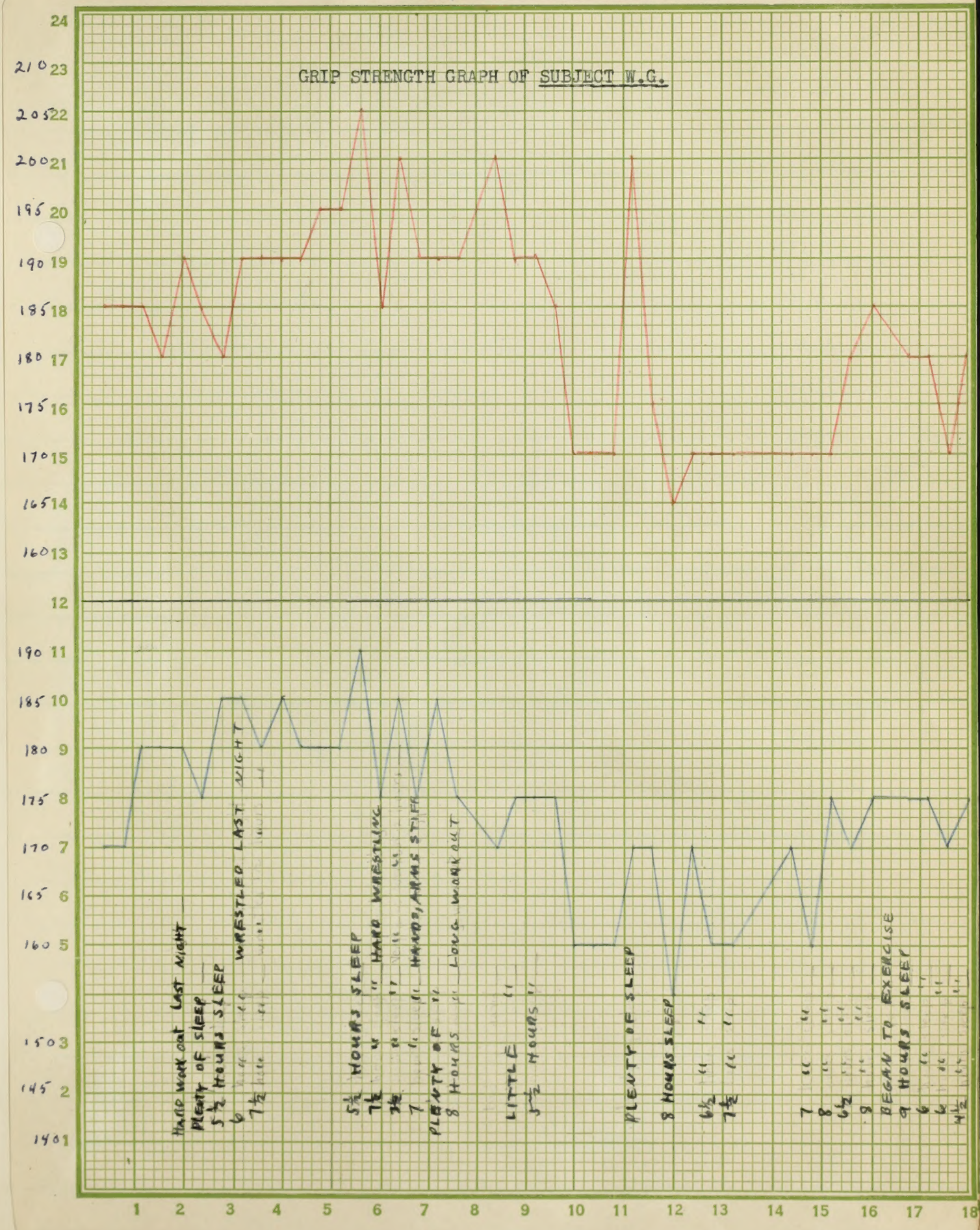
Chart XXIV is a graph for W.G., who was tested from December 1 to December 15; from January 3 to January 11; and from February 4 to March 7. This subject was a varsity football player in the fall, and practiced some with the wrestling squad in the winter. Days on which he wrestled are marked on the chart. Though carrying a normal academic program, and working forty-five hours a week, he gained six pounds in weight during the testing period. The grip strength of this subject was affected more by exercise than by any other factor. During periods when he participated in wrestling his grip-strength was up around 200 for the right and 185 for the left; while during periods when he did not exercise his grip dropped to around 170 for the right, and to 160 for the left.

Chart XXV on pages 117-8 is a graph for L.O., whose testing period corresponded with that of W.G. He worked forty hours a week, carried on a daily program of calisthenics, did not get as much sleep as an active college student should, but followed quite a regular program. It apparently took him about a week to acquire the technique of squeezing the instrument. After that he attributed his improvement and maintenance of a fairly high score to his regularity of exercise.

Chart XXVI on pages 119-20 is a graph for J.T., who was tested from February 4 to March 7. Though a varsity football player, he did not exercise much during this period because of an appendicitis operation during Christmas

Gavin, Bill

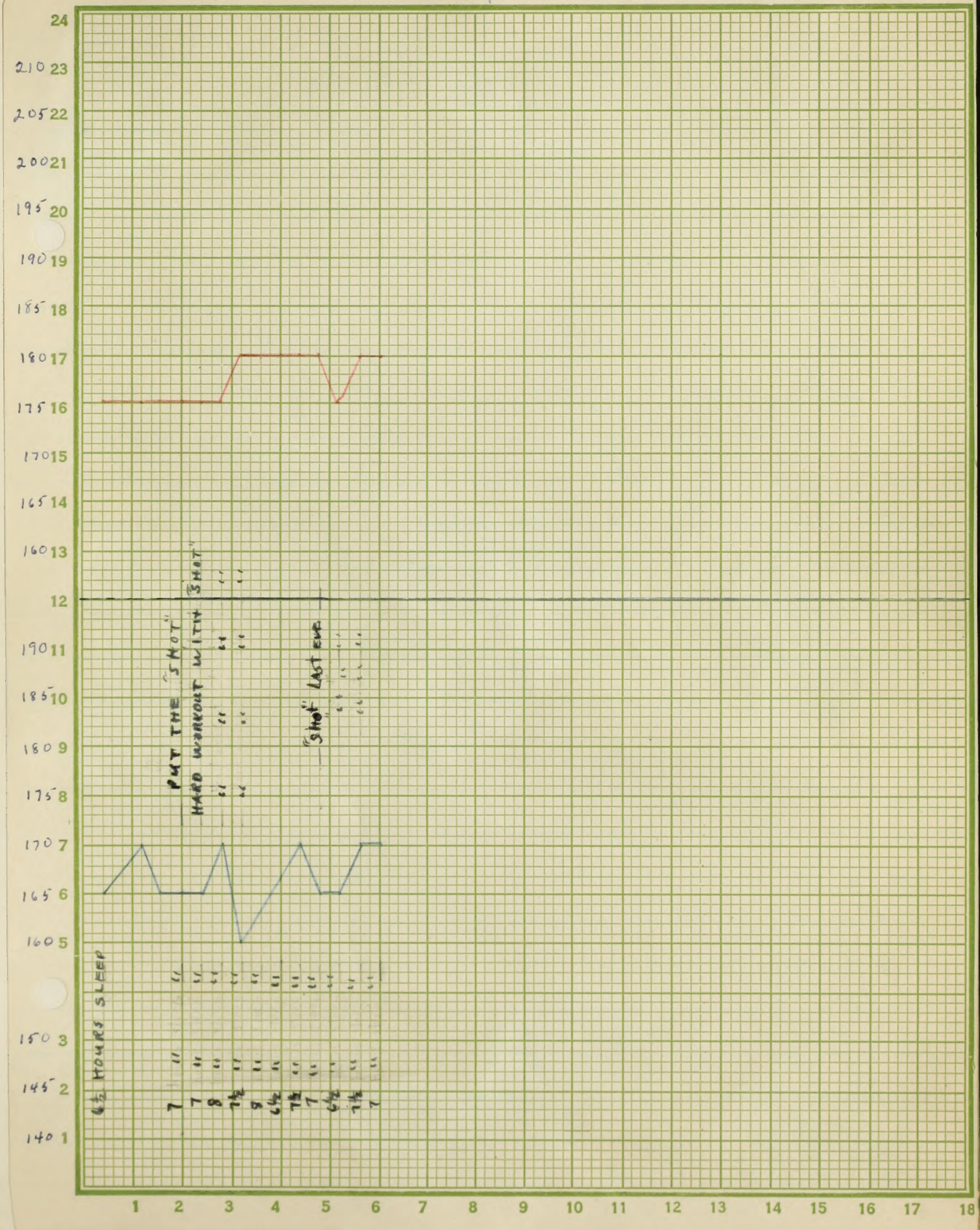
Right — 115
Left — CHART XXIV



Gavin, B:11

Right –
Left –

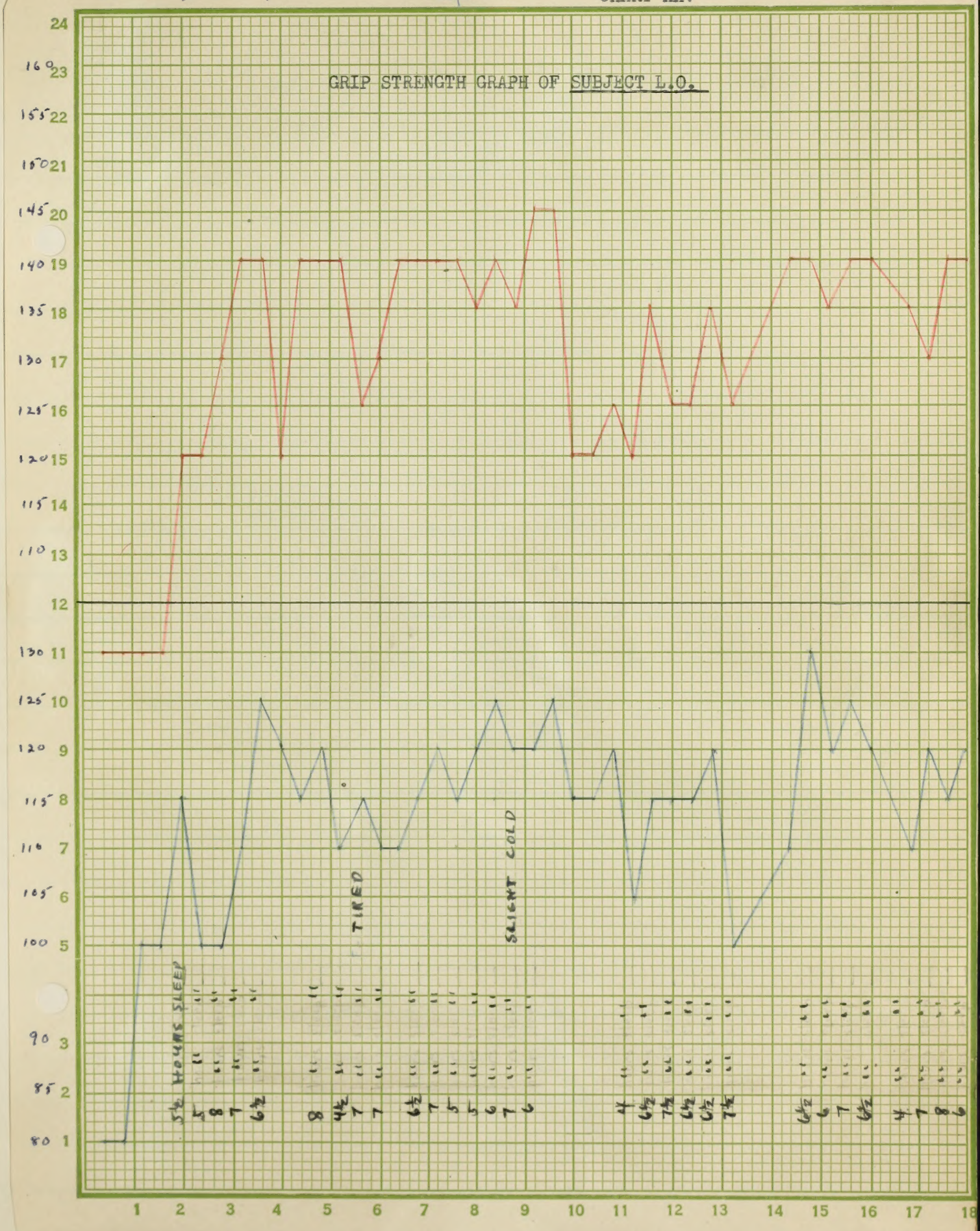
CHART XXIV--CONTINUED



Oliver, Leroy

Right —
Left —

117
CHART XXV



Oliver, Leroy

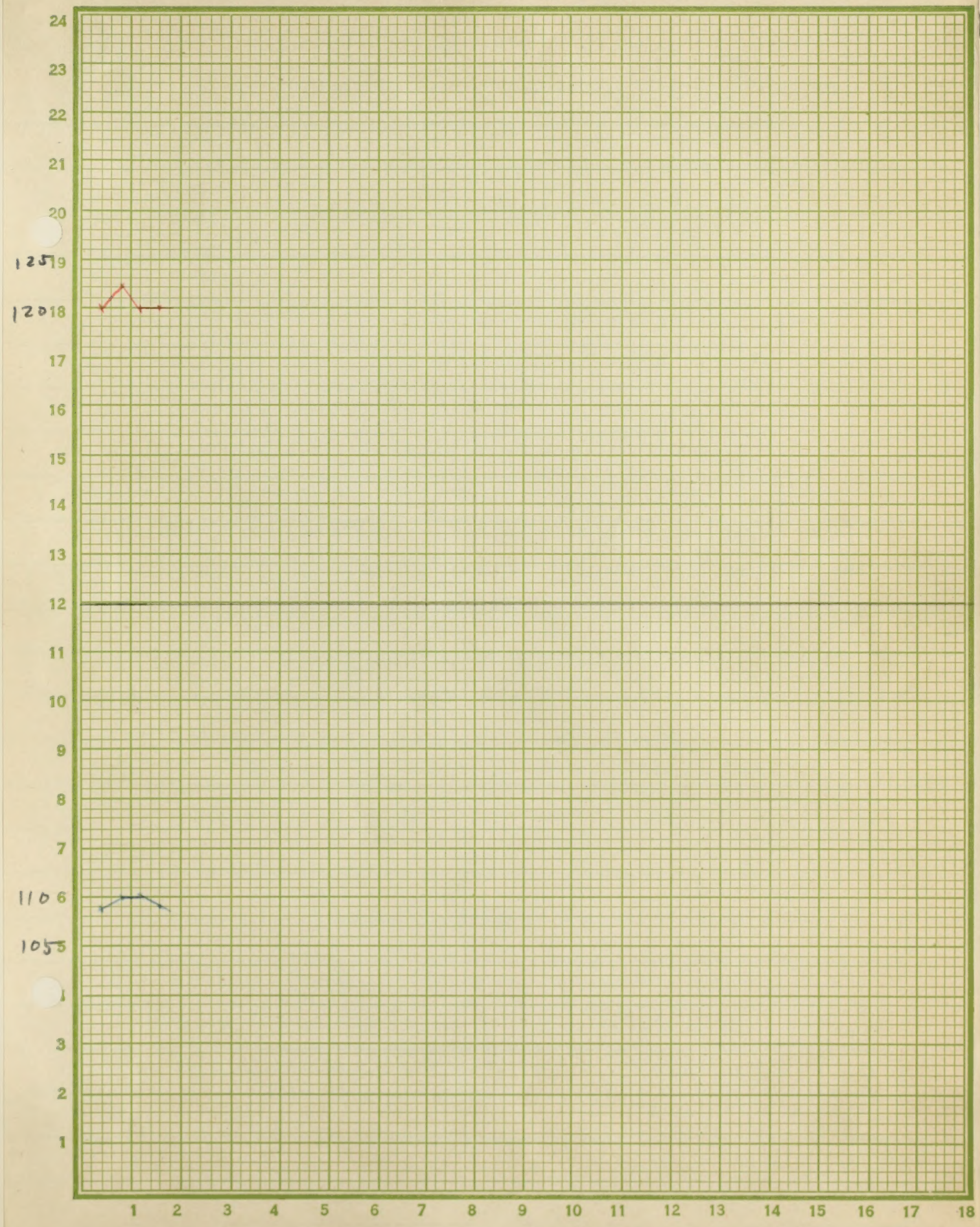
Right —
Left —

CHART XXV--CONTINUED

CHART XXVI


GRIP STRENGTH GRAPH OF SUBJECT J.T.
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CHART XXVI (CONTINUED)



vacation. His living habits were very steady and he had no sickness during the period. As will be noticed, his grip-strength scores were very steady. Of three noticeable increases in right-grip, two can be accounted for by more than the usual amount of sleep. The third increase which showed a rise of from 120 to 140 in right-grip, and from 95 to 110 in left-grip was not accounted for.

Chart XXVII on pages 122-3 is a graph for J.C. who was tested over the three periods which totaled a full seven weeks. He worked fifty hours a week and had an erratic sleep schedule, which noticeably affected his grip-strength scores. At one time he was put to bed and kept under observation for appendicitis for two days. His lowest scores were recorded when he was tested one day while in bed, but since it was awkward for him to squeeze the instrument while in bed, and since it was feared the effort might be harmful to him if he did have appendicitis, the test was not repeated until he came back to work. He did not have appendicitis and immediately regained his normal grip when he resumed work.

The rest of the graphs for this group are not included because they neither contribute to nor detract from indications or conclusions drawn from other graphs.

Boiler Room Workers

This group was composed of five men who shoveled coal in the boiler room. The men were taught the testing technique, and each tested himself when he started and when he finished work, for a period of one month.

CHART XXVII


GRIP STRENGTH GRAPH OF SUBJECT J.C.
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CHART XXVII (CONTINUED)

Since the work was heavy it was hoped that some findings dealing with fatigue would be realized, but working hours varied so much as to length and time of day that it was impossible to adequately group results for an accurate study of fatigue.

During the month only one subject reported a cold. This cold lasted through a period of six testings, during which time his average right-grip dropped 16.04 points and his left grip 11 points below normal.

Janitor Group

This group of twenty-one men was checked from January 27 to March 11. Tests were given when these men came to work and when they finished work. These men worked from five to seven o'clock each morning. Causes of changes in scores were investigated, and whenever a cause was determined it was recorded.

Scores of this group add further evidence to substantiate the belief that one's physical powers are at low ebb the first thing in the morning. Two hours of janitor work do not cause fatigue enough to overcome the natural diurnal changes of a healthy individual. Of the twenty-one subjects, nineteen showed gains in the right grip in the two-hour period ranging from .9 to 17.3 points. One lost .6 points, but more than counter balanced it with a gain of 6 full points in the left. The other lost .6 points for his right, and 1.3 points for his left. In the twenty other cases of left grip comparisons, eighteen showed gains; one lost .3 of a point while gaining 13.1 points, right; and another lost 1.7 points while gaining .9 of a point, right. Gains in left grip ranged from 1.7 to 22.1. The average gains for the entire group were 6.12 points, right grip; and 7.15 points, left grip.

The majority of these men went through the testing period without any noticeable causes for physiological changes. In general, scores were steady, though in a few cases there were deviations, which could not be accounted for.

Six of the men reported abnormal conditions and each of these six will be discussed separately.

Subject K.B. reported one cold which brought his grip strength down 10.94 points for the right and 3.7 points for the left below his normal pre-work average. After work he was 4.12 points below his normal post-work right and 4.41 points below his normal post-work left averages.

Subject C.G. reported falling below par one morning because of having teeth extracted the evening before. He was 11.1 points below his normal pre-work average right grip and 1.7 below his normal pre-work average left grip. He failed to retest after work that day.

Subject S.K. reported one cold which brought his scores 17.8 and 23.7 points below his normal post-work average. He failed to test before work at this period.

Subject R.W. reported one unusual day. His pre-work test was quite normal, being .3 points, right and .8 points, left above normal pre-work averages. His work that day called for some extra duties, which necessitated his driving a car into a neighboring town. He had to drive through traffic in a great hurry. This induced a state of nervous tension. It was immediately after this trip that he finished work and retested 26.3 points, right and 7.8 points, left above his normal post-work averages. This is another indication of the effect of emotional "keying up" on grip strength.

Subject J.S. reported one morning following a night of very little sleep. He failed to test before work, but after work was 20.7 points, right and 11.4 points, left below normal averages for that testing period.

Subject N.D. reported several colds, and during the periods of these he showed little ill effects from them before work. Before work he averaged 1 point below normal right and 4.1 points above normal left. After work, however, he was 9.39 below his post-work normal right average, and 7.46 points below his post-work normal left average. These very noticeable comparative losses in grip-strength during two hours of early morning work seem definitely associated with a lower degree of physical fitness due to colds. This subject was a regular participant in intra-mural athletics, and evidently was conditioned so that the tests before work did not reveal a weakened condition, but he did not have the stamina to throw off fatigue effects of work on days of colds as he was able to on normal days.

Summary

A study of students other than athletes indicates that the same factors: minor illness, amount of sleep, fatigue, and emotional tension affect grip-strength.

A few additional observations were noted. It seems that individuals with daily regular programs tend to fluctuate in grip-strength less than those who are irregular in their activity and rest. Exercise, except when engaged in to excess, tends to increase grip-strength. During two hours of moderate work

in the morning the grip strength of college men in good health tends to rise, indicating that the natural gathering of powers in the morning should be sufficient to counterbalance average fatigue effects. A rest period following a strenuous season of sport seems to be helpful.

CHAPTER VII

SUMMARY

This study has aimed to determine the factors and conditions in the life of college men which cause grip strength to fluctuate. It has sought to determine whether or not a daily grip strength test would be a useful measure for athletic coaches. Finally, it was sought to probe the possibilities of forecasting physiological changes by means of grip strength tests.

From a study of one hundred forty college men it seems evident that such factors and conditions as normal exercise, regularity in rest and activity, and other proper health habits bring about a rise in grip strength. Contrarily over exercise, minor illness, loss of sleep, and worry bring about a decline in grip strength. Since it is axiomatic that any one of the above brings about physical changes for better or for worse, it is logical to conclude that an increase in grip strength indicates a rise in general physical powers and a decrease in grip strength indicates a decline in general physical powers.

Coaches interested in maximum results, to say nothing of the physical welfare of their men, must give attention to daily physical fitness. Only two methods are in common use today, subjective observation and the keeping of weight charts. A subjective examination of men takes much time and is very susceptible to error. Weight changes are very difficult to analyze because loss of weight in many instances is merely a loss of water, and does not affect physical power, some weight losses accompanying

a decline in fitness and others an increase in fitness. In chapters II and III, group and individual examples are cited to show that weight changes are, many times, inverse to physical fitness changes. A light workout, after a day of physical inactivity in class rooms, while causing a loss of body weight, seems to stimulate capacity for activity. Wrestlers up to a certain point can purposely reduce weight, and still gain in physical condition, but beyond that point further loss will reduce condition. Whereas weight is a very deceptive measure of physical fitness, all evidence gathered thus far indicates that grip strength is a consistent barometer of increases and decreases in general physical powers.

Grip strength, not only seems to be valid as a method of checking daily physical fitness, but it is reliable, objective, economical, and interesting. One study[1] found a reliability coefficient of .92 with the right grip test, and of .90 with the left test. The technique of grip strength testing is very simple, and so long as the testers are interested and careful it is highly objective. A first class manuometer costs fifteen dollars, and the test for both right and left grip can easily be administered in less than one minute. Even though practice time for school athletics is very limited, one minute is a small proportion of the total time to determine the fitness for activity of a player. With a little training, a dependable student assistant manager could easily administer the test. There is no difficulty in interesting men and boys in tests involving strength. During this research the subjects were intensely interested in their scores, and were constantly striving to do better.

[1]Frederick Rand Rogers, FUNDAMENTAL ADMINISTRATIVE MEASURES IN PHYSICAL EDUCATION, Newton, Mass.: The Pleiades Co., 1932, p.147.

Athletic coaches can find much practical value in grip strength testing. As was previously stated, it can be used as a check on the faithfulness of men in observing training rules. It can be used to detect men who are concealing illness, and to determine how soon after sickness or injury one is physically able to get back into strenuous sport participation. It can be used to indicate the amount and type of practices which are the best for getting and keeping men in the best possible condition. Chapter II reviews the effects of different types of practices on varsity wrestlers. Individual case studies, reported in the same chapter, cite instances where men, because of changes in grip strength, were diagnosed as being in the early stages of staleness, and, in some instances, were rested in time to restore good physical condition. Some wrestlers can reduce weight to compete in a lower division, and still maintain maximum efficiency, while others will be weakened by doing so. Grip strength reveals such effects. Grip strength testing can be used to help determine the physiological value of activities. Studies, reported in this paper, indicate that most athletic activities are physically helpful. They also indicate that basketball, as it was played under the 1937-38 rules, was too strenuous for college men. Studies of diurnal changes in grip strength contribute evidence that mens' physical powers fluctuate during the course of a day. This is apparently not so much due to any particular time of the day, but is closely related to the individual's sleeping, eating, and activity schedules.[1] Further studies of this sort should enable one to time a day's program in order to have maximum physical efficiency when it is most needed.

[1] Coleman R. Griffith, PSYCHOLOGY AND ATHLETICS, New York: Charles Scribner's Sons, 1928; p. 200.

Further evidence that grip strength is affected by minor illness and by health habits is offered in the study of five student groups, totaling seventy-eight men. Invariably decreases in grip strength could be traced to minor illness, loss of sleep, worry over examinations, strenuous exercise while out of condition, or some such cause.

While the possibilities of grip strength tests are worthy of much more research, it seems certain from studies already made that they are valid; that they are the most useful measure known today for an athletic coach to check the daily fitness of his men, and that there are definite indications that can be used to foretell physiological changes, such as staleness, before such changes have actually occurred.

Problems Yet Unsolved

The writer plans to carry studies in grip strength testing further. It is planned to correlate grip strength changes over longer periods of time with P.F.I. changes. It is also planned to correlate changes in grip strength with results in athletic skill tests. This will be done by administering skill tests to subjects at times when their grip strength is at low ebb, at a normal level, and at peaks. Ultimately we should know just how valid the grip strength test is as a measure of physical status in relation to one's own normal condition.

BIBLIOGRAPHY

BIBLIOGRAPHY

Bilik, G. E., THE TRAINER'S BIBLE, New York: The Athletic Trainer's Supply Company, 1928, 247 pp.

Recommends methods for detecting and treating staleness.

Blakeman, Ralph N., Perry S. Jackson, and Frederick Rand Rogers, FURTHER ADVENTURES WITH GRIP STRENGTH TESTS. Newton, Mass: The Pleiades Co., 1936. 20 pp.

Presents a challenge to all who are interested in probing vital problems.

Crisler, H. O., and E. E. Wieman, PRACTICAL FOOTBALL. New York and London: McGraw-Hill Book Company, Inc., 1934. 242 pp.

Discusses staleness and emphasizes the importance of preventing this condition among athletes.

Fay, Paul J. and Lloyd L. Messersmith, "The Distance Traversed by College and High School Basketball Players and Effect of Rule Changes upon Distance Traversed in College Games", Athletic Journal, 18: 37-39, April, 1938.

This article presents clearly a contrast between distances traversed by basketball players in games played in 1938 and 1931. It would have been more helpful if figures could have been presented for 1936-37 as well.

Gates, Arthur I., PSYCHOLOGY FOR STUDENTS OF EDUCATION, New York: The MacMillan Company, 1930. 605 pp.

Used in this study to compare findings with those of men in related fields.

Griffith, Coleman R., THE PSYCHOLOGY OF COACHING, New York: Charles Scribner's Sons, 1932. 208 pp.

Used to get a psychologists slant on emotional effects.

_____, PSYCHOLOGY AND ATHLETICS. New York: Charles Scribner's Sons, 1928. 273 pp.

Discusses methods of securing maximum results in the handling of athletes.

Hall, G. Stanley, ADOLESCENCE, Volume I, New York: D. Appleton and Company, 1904. 589 pp.

Dr. Hall devotes one chapter of this fascinating volume to "Growth of Motor Power and Function". He concludes that the muscles are of vital importance; and that if we fail to develop them it will be impossible for us to reach goals we could otherwise reach.

Heim, Fred V. and A. J. Randall, "Effects of the Center Jump Elimination", Scholastic Coach, 7: 16, April 1938.

This is a report of a splendid study of ninth grade boys. It would have been still more pertinant to this study if it had included college men.

Lambert, Ward, PRACTICAL BASKETBALL. Chicago: Athletic Journal Publishing Company, 1932. 243 pp.

Another basketball text which discusses staleness.

Mather, E. J., and E. D. Mitchell, BASKETBALL, Ann Arbor, Michigan: C. W. Graham, 1922.

This is one of the older basketball publications, but it is as up to date on causes of staleness and methods of treatment as any of the newer ones.

Murphy, Gardner, GENERAL PSYCHOLOGY. New York and London: Harper and Brothers Publishers, 1933. 657 pp.

Gives a good discussion of fatigue and fatigue effects.

Rogers, Frederick Rand, EDUCATIONAL OBJECTIVES OF PHYSICAL ACTIVITY. New York: A. S. Barnes and Company, 1931. 111 pp.

Stresses the importance of building and conserving health, and dignifies this type of service.

_____, FUNDAMENTAL ADMINISTRATIVE MEASURES IN PHYSICAL EDUCATION. Newton, Mass: The Pleiades Company, 1932. 261 pp.

A standard text for tests and measurements in Physical Education. Used in this study to help justify the grip strength test as a proper measure.

_____, PHYSICAL CAPACITY TESTS, New York: A. S. Barnes And Company, 1931. 50 pp.

Explains proper techniques in strength testing.

Ruby, J. Craig, COACHING BASKETBALL. Champaign, Illinois: J. Craig Ruby, 1931. 305 pp.

Discusses staleness.

Whipple, Guy M., MANUAL OF MENTAL AND PHYSICAL TESTS. Baltimore: Warwick and York, Inc., 1924 367 pp.

Reviews tests and testing studies, including grip strength.